POWER

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FRED R. LOW, *Editor*

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Merry Christmas!

ONCE again, in the name of *Power* and of all who have to do with its management and making, I am privileged to wish to all to whom these presents may come a Merry Christmas and a Happy New Year.

For a time attention is diverted from routine and personal pursuits to thoughts of what can be done to add to the pleasure of the Christmas season for others:

To make this break in the mingled whirl and humdrum of the year a time of real festivity, the Christmas of Dickens, of glad hearts glowing with Good Will Toward Men.

From the tot who has still to suffer the disillusionment of Santa as a real living being to those who have come to realize his existence in the spirit which pervades this season of concern for others, may there come to all a full measure of happiness and good cheer.

To the victims of poverty and misfortune the generous impulses induced by the Christmas Spirit bring a seasonal respite from their privations, a gleam of sunshine and a touch of human fellowship. May the revelation of their necessities result in their lasting amelioration.

The Great Reformer whose birth we celebrate did not say, "The poor ye *will* always have with you." The earth in its fulness has enough for all. It is a tragic paradox in our social-economical system that the increasing ease of the adaptation of natural resources to human use should result in the reduction of opportunity to those who are willing and fit to share the labor and participate in the benefits; that unemployment should, next to death or disability, become the greatest of human dreads.

May selfishness, ambition and fanaticism be overcome and the universal brotherhood of man be fostered by the growing Will for Peace, of which He was the Great Apostle.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

A Questionable Policy of The U. S. Reclamation Service

SMALL wonder the United States is considered progressive. The President's recent conferences with the business, transportation, industrial and public utility interests are without parallel and demonstrate what may be accomplished, given the will to do and loyal business and industrial co-operation.

As a result of these meetings, there is evidence of returning confidence and a sense of security as to the future which is of first importance to the continuance of business and prosperity. The Federal Government should rightly expect the support of the leaders of industry which has been so unstintingly given. Likewise industry should be privileged to expect—and, in most instances, meets—a reciprocal attitude from the Government.

In view of this, it is difficult to understand why the Reclamation Service continues to make its own designs for some of its machinery and does not always accept bids upon manufacturer's designs for the required service.

It is true that many years ago designs of large capacity discharge valves, sluice gates, transitions and other appurtenances used for water regulation at dams and in connection with hydro power projects had not reached their present state of perfection; and government engineers may have felt justified in the belief that they had to use machinery made to their own ideas. However, the great number of major projects that have been constructed and successfully put into service in recent years by private enterprise is evidence enough of the present-day suitability of manufacturers' designs for any need of the Reclamation Service.

It may also be claimed that the Government cannot secure the best job at the lowest price unless all bidders figure upon a single design prepared by government engineers.

Cases are on record, however, in which otherwise responsible low bidders have lacked the particular manufacturing experience necessary for successful construction. Thus an apparently low bid on Government designs may prove a very expensive one when charged with the cost of correcting errors and delayed completion of the entire project.

It is thoroughly sound public policy and good business for the Reclamation Service to receive proposals from reliable manufacturers, upon suitable designs of proven merit.

Is the manufacturer not entitled to this consideration?

Diesels for Central Stations

READERS may not agree entirely with the deduction of F. W. Martin appearing on another page, as to the non-usefulness of the Diesel engine for central stations; nevertheless the advantage of the argument is with the steam plant when central stations are being considered.

Large steam plants can and do have an over-all operating cost below that possible with the Diesel engine. It is not surprising, then, that when output is considered central station power is "steam power."

The field for Diesel application is essentially those industrial plants where there is not a use for all the exhaust steam that would be delivered by the steam engines or turbines needed to carry the power load. While the large steam central station can and does generate power more cheaply, when the industrial user must pay, as he properly should, the overhead cost of the tranmission lines and the line electrical losses, it is by no means universally true that power from steam plants is cheaper than that developed from Diesel engines on the consumer's premises.

Consequently, the unfavorable cost cited by Mr. Martin by no means proves that steam is always king. Each plant must be examined with its own conditions uppermost in the mind of the engineer. Conclusions such as have been made from time to time by advocates of both steam and Diesel power must be accepted with caution and with an appreciation of all the facts involved.

Statistics—Another Engineering Science

ENGINEERING is the application of "fundamental sciences" to practical purposes. What are these fundamentals? First came physics, chemistry and mathematics. Then it was seen that economics is an essential factor in every engineering problem. Today the technique of economic balance has won its place in every branch of engineering. Engineers talk of investment, fixed charges, and obsolescence in the same breath with torque, tensile strength, and British thermal units. What will come next? Probably the general application of sound statistical methods to engineering problems.

Few engineers today have any adequate understanding of the theory of statistics, or realization of its practical application in the engineering field. Yet assumptions relating to interest rates, depreciation, obsolescence, load curves, and even the properties of materials, are merely

more or less unconscious applications of the theory of probability. Probability, in turn, is the basis of the statistical theory.

For years, in his frank moments, the engineer has termed the factor of safety a "factor of ignorance." In designing a structure or machine he looks up the tensile strength of long-leaf pine, say, or cast iron or low-carbon steel, in his handbook and then proceeds to demonstrate his lack of confidence by tacking on a factor of safety of three or five.

The real trouble, according to statisticians who have looked into engineering matters, is that the "tensile strength" given by the handbook is not the strength of any single sample, but an average. Actual samples may vary widely from this average. Obviously, the distribution of this variation is just as important to the engineer as is the average value—in some cases more so. It is not unlikely that engineering handbooks in the future may give not merely average values of so-called "constants," but may also give curves or figures indicating the extent and distribution of the variation from the average.

This is just one practical application of statistics in engineering. Many others are possible. For example, methods of telephone load prediction developed by the A.T. and T. engineers might well be applied to the prediction of load curves for central stations, public buildings and industrial establishments.

Lack of Balance Between Steam and Hydro

WHILE the utilization of water power is one of the truest forms of conservation, it must be admitted that hydro-electric installations have not always been based upon sound engineering. Sentiment plus popular appeal have occasionally resulted in overdevelopment of water power resources without regard to what may be the best plan for power service in the community. Attempts to convince the authorities that continuity of service demands a proper proportioning of steam and hydro power have often proved futile.

Failure properly to regard sound engineering judgment of this sort has now resulted in several distressing situations in the Pacific Northwest. As a result of almost unprecedented drought during the past summer and fall, the cities of Tacoma and Seattle find themselves virtually unable to supply the power demands from existing hydro systems. Steam stand-by capacity is insufficient to make up the remainder of power required, and every possible means is being used to augment the present steam capacity. Emergency tie-lines are being installed to connect the individual industrial steam plants having an excess of power capacity beyond their immediate needs, and, according to latest reports, the airplane carrier "Lexington" has been brought to the rescue of Tacoma, through emergency tie-lines. The country also is being combed for boilers and any other apparatus available, whether new or used.

The local newspapers of Vancouver, B. C., are taking up the cause for increased steam stand-by capacity in that community and are openly deploring the fact that while some of the power company engineers more than a year ago recommended a steam stand-by installation to properly balance the power system, their plans were overruled by a higher authority that favored future development of water power. In the meantime the territory has a distinct power deficiency. A similar condition obtained in the Southeast a few years ago as a result of which many steam plants were subsequently built in that section.

It is hoped that the trouble encountered this year in the Northwest will sufficiently emphasize the fact that a proper balance does not exist at present between steam and hydro, and so give force to a definite program for the installation of steam stand-by equipment immediately.

Stand-by Equipment in Industrial Power Plants

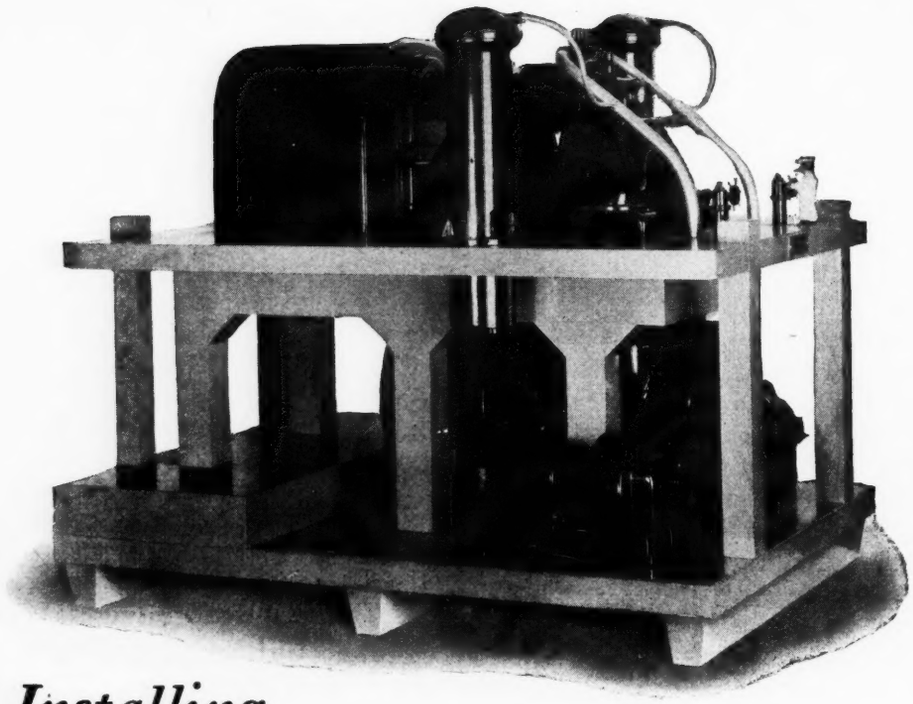
ALTHOUGH, as pointed out by an editorial in a recent issue of *Power,* stand-by equipments are essential in plants serving offices, hotels, and the like, it by no means follows that an industrial plant is always justified in installing excess power units, thereby increasing capital charges and the cost of power.

There are, of course, many factories where continuity of operation is essential. For example, in a dye works discontinuance of power services might ruin all the goods being processed. The same might apply to other particular industries, but broadly speaking the actual property loss due to a shutdown is usually small and only a decrease in profits is suffered by the mill, for wages terminate automatically when the machine stops. Moreover, profits can be protected easily and cheaply by one of the several forms of breakdown insurance.

When power is purchased from the utilities, factory managers seem to feel that the interruptions to service are not frequent enough to justify the installation of a breakdown power plant, and quite reasonably so. But where power is generated on the premises, some managements think it praiseworthy caution to install spare units. This, however, may be merely placing the stockholders' money in an unjustified and unnecessary investment.

The present-day engine and turbine is too reliable to justify any belief that it is not able to operate continuously. An examination of insurance records covering flywheel and engine trouble indicates that there is little likelihood of shutdown from these causes. Even in the event of engine or boiler accidents the presence of standby units will not offer the guarantee against shutdown, for the breaking of a flywheel or a turbine casing may put the whole plant out of business. If the accident is a minor one boilers and generating units in service can carry the extra load.

Consequently a careful analysis may show that money for contemplated spare unit purchase will be more profitably employed in other parts of the power plant.



Model of Ford 110,-000-kw. double-deck turbine generator

FORD Installing

WORLD'S LARGEST HIGH-PRESSURE UNIT

. . . 110,000-kw. steeple-type turbine-generator and two 1,200 lb. boilers of 700,000 lb. steam capacity to go in Rouge plant

TO MEET increasing power-generating demands at its Rouge plant, the Ford Motor Company has decided to install a 110,000-kw. turbine unit operating at 1,200 lb., which will be supplied by two boilers each capable of furnishing 700,000 lb. of steam per hour. These boilers are unusual in that they will have the greatest steaming capacity of any boiler yet laid down for this pressure and will be installed in practically the same size casing as the older boilers of the plant, which have about one-third the capacity. The turbine unit, which is to be of the newly developed steeple floor-saving design, is not only the largest of this type, but is also exceptional because the high-pressure element will be mounted on the low-pressure casing and both generators will be of the same size and speed, one placed above the other. Steam will be supplied at 750 deg. and live steam reheaters will heat the steam between turbines. Four-stage extraction will be employed for feed-water heating and economizers as well as air preheaters will be used. The fuel will be blast-furnace gas and pulverized coal.

Before going into further details concerning these new units, it will be pertinent to review briefly the conditions that led up to the decision to enlarge the capacity of this plant.

As a part of the plan for increasing production of the Model A Ford practically all the equipment of the Highland Park shops had been transferred to the Rouge plant, with the result that the power requirements of the consolidated shops now exceed a normal demand of 100,000 kw., with peak loads at times reaching 136,000 kw. In *Power* Nov. 23, 1920, and Mar. 1, 1921, the original Rouge power plant was described. Briefly, this original plant was planned for a total generating capacity of 65,000 kw. in four units. Under this plan the first two units, of 12,500 kw. each, were put into operation. The unexpected rapidity of growth of the power load thereafter made it necessary to revise the original estimate. By careful planning it was found that eight 30,000-kw. generating units of Ford make could be installed within the building originally designed for four units. Develop-

ment under this plan proceeded until there were added to the original 12,500-kw. units four of the 30,000-kw. machines, thus bringing the total installed capacity to 145,000 kilowatts.

Originally, eight 26,470-sq.ft., boilers operating at 250 lb. pressure and 250 deg. of superheat had been installed. Blast-furnace gas and powdered coal were used as fuel. Although the boilers had been designed to operate at 250 to 300 per cent of normal rating, it was found necessary to increase the capacity of four of them to keep pace with increased turbine demand. Their output was practically doubled by enlarging the furnaces and adding water-wall surface, as described in the July 13, 1926, number of *Power*.

At this point it became evident that the relation between the ever-growing demand for power and the remaining economic possibility for the expansion of the existing facilities required adjustment. As a result of the ensuing studies, the advantage in the use of higher steam pressure became evident. Consequently, the latest addition to the Rouge power plant, now under way, will represent the most approved practice in the design of high-pressure turbines, boilers and auxiliary equipment.

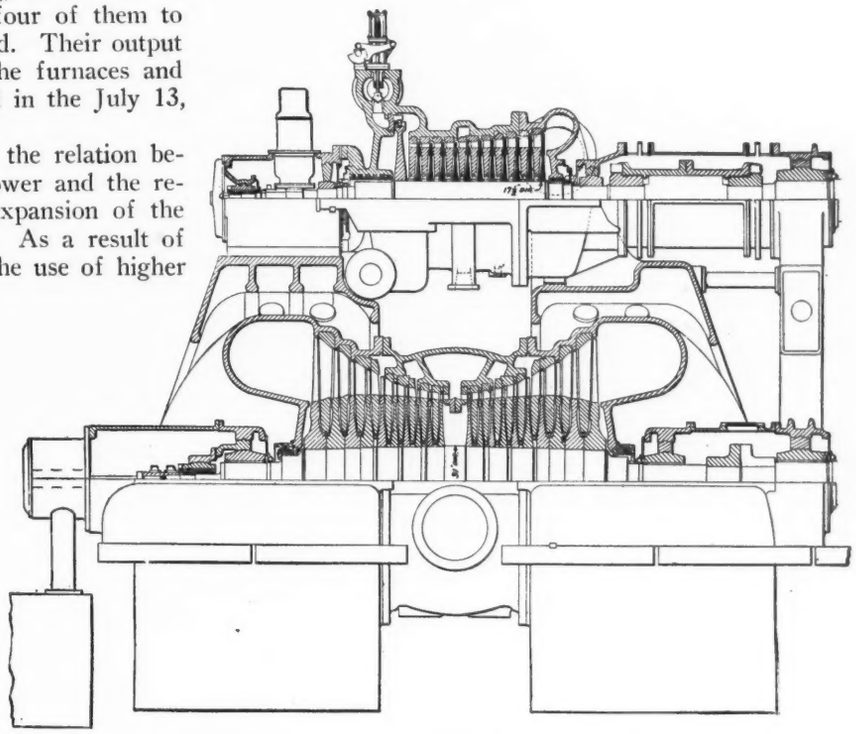
The over-all operating economy of the new installation is expected to be better than any heretofore secured at this plant. The best results at present show a consumption of 15,000 to 16,000 B.t.u. per kilowatt-hour delivered, while the high-pressure installation is expected to operate with an average economy of 13,000 to 14,000 B.t.u. per kilowatt-hour, the turbine alone requiring but 9,675 B.t.u.

It is both interesting and significant that in the present remodeling plan the original two 12,500-kw. turbines will be removed. In the space thus provided, one new 110,000-kw., steeple, compound turbine-generator will be placed and room will remain for the addition of the second turbine of the same size later on. Two of the original boilers will make way for the two high-pressure boilers required for the one turbine-generator now being installed. Later the two remaining original boilers will be replaced by high-pressure boilers when the second steeple turbine-generator is put in.

Boiler Room Data

Surface in the boiler proper, sq.ft.	32,040
Surface in furnace water walls, sq.ft.	4,220
Surface of bottom water screen, sq.ft.	770
Surface of arch screens, sq.ft.	680
Surface of two plain-tube economizers, sq.ft.	11,800
Total water heating surface per boiler, sq.ft.	49,510
Total air heating surface per boiler, sq.ft.	64,800
Economizers, two, 2½-in. plain tubes, 23 ft. long; total surface, sq.ft.	11,800
Air heaters, two; total surface, sq.ft.	64,800
Induced draft fans, two; drive 575-hp. motor; capacity 400 deg. gas, cu.ft. per min.	180,000
Forced draft fans, four; drive 85-hp. motor; capacity of each, cu.ft. per min.	37,500

The new high-pressure boiler units will follow closely the remodeled design previously referred to. The new boilers will be quite similar, but of heavier construction and increased capacity. Each of the two boiler units, consisting of two double-set Ladd boilers with 32,040 sq.ft. of water-heating surface, will be able to deliver a maximum of 700,000 lb. of steam per hour (with a continuous output of 600,000 lb. per hour) at 1,350 lb. per square inch pressure and a temperature of 750 deg. F. The upper and lower drums, interconnected by three banks of tubes, will form semi-vertical elements on each side. Drying tubes will carry the output from these elements to a central steam drum located above and outside the casing.



Vertical section through steeple-compound turbine

There will be four water drums with a shell thickness of 5¼ in. and one steam of 3-in. metal. All will be 40 in. diameter and made of forged steel. The two top water drums will be 35 ft. in length; the two bottom drums, 30 ft. 6 in. long; and the steam drum, 25 ft. over-all. The boiler tubes will be 3 in. outside diameter. Superheater headers will be located centrally under the steam drum, with the elements running downward into the first bank of boiler tubes on each side.

With the centers of the lower boiler drums 47 ft. above the operating floor, an effective combustion volume of approximately 27,000 cu.ft. will be secured. Plan dimensions of the furnace are 27 ft. long x 26 ft. wide. The four walls of the furnace will be protected by continuous water-cooled metal surface of vertical finned tubes spaced on 5⅛-in. centers. Fins on these tubes are 1 in. long and ¼ in. thick. At top and bottom the tubes will curve through the setting wall to headers connected into the boiler circulation. A bottom water screen will be constructed of 3-in. plain tubes curving downward from headers at the front walls into a central drum below the apex of a central ashpit structure. Water screens of the finned-tube type will protect the lower drums. Tabulation of water-heating surfaces is given in Table I.

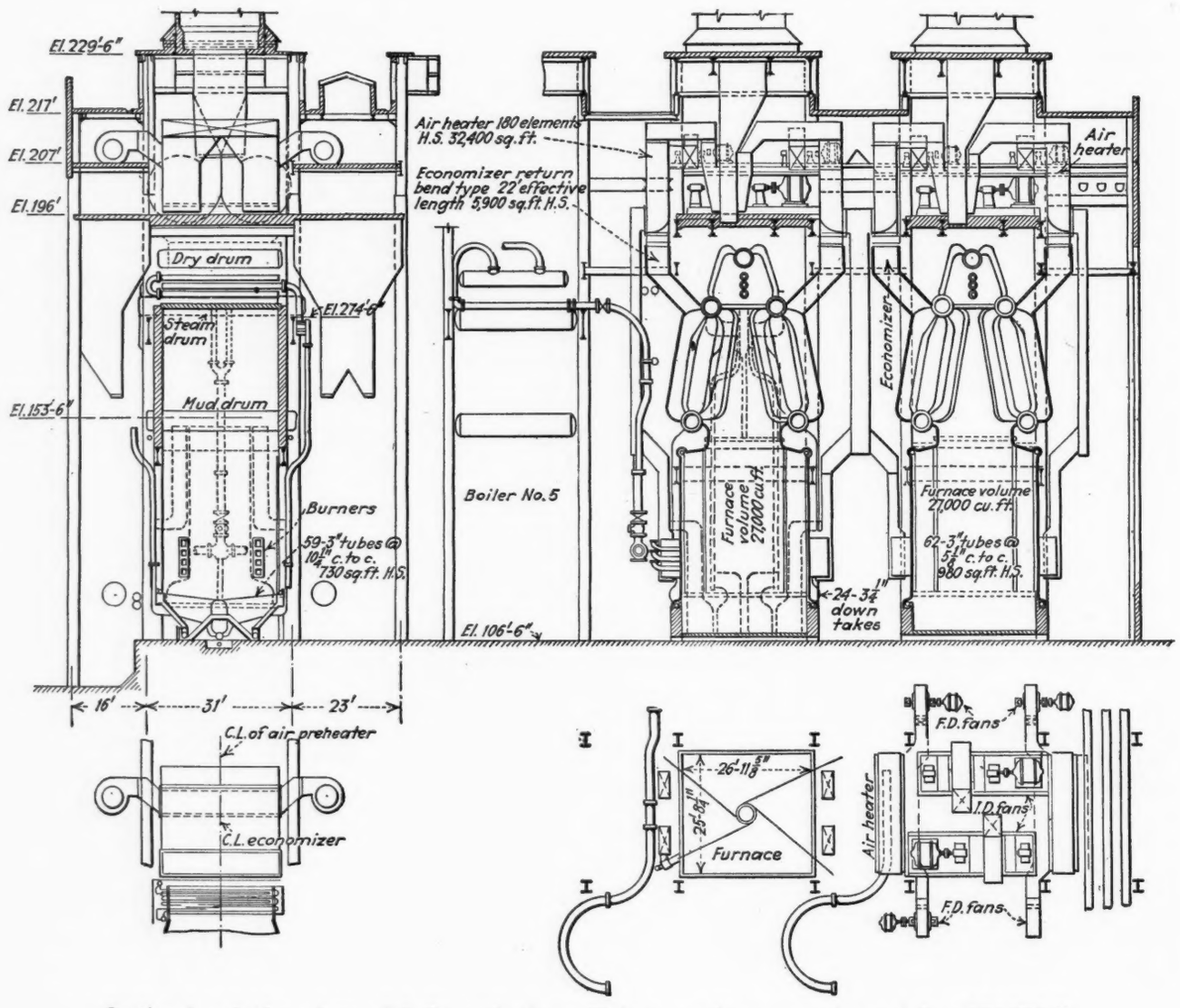
In regular operation the fuel will be a combination of blast-furnace gas and pulverized coal. All of the available blast-furnace gas will be fired through a burner located centrally in each boiler front. The remainder of the required amount of fuel will be pulverized coal delivered from the present preparation plant. For this

service blowers having a capacity of 50,000 cu.ft. per. minute against a maximum static pressure of 14 in. of water will be used. Six burners with air-mixing chambers and adjustable air dampers will be placed on either boiler front. These will be arranged three high at each corner of the furnace and point tangentially toward a circle within the furnace to produce a whirling vortex of flame to secure the best mixing of the combustion components.

Over the gas uptake on either side of the boiler there will be a plain-tube economizer. Above these economizers duplicate air heaters will be set, and at a higher level will be the fans, which will be motor-driven. The induced-draft fans will be placed centrally so that they may discharge directly into the base of the stack. At the same level each boiler will have four forced-draft fans that will draw the warm air from the top of the boiler room and discharge it through the preheaters to the furnace wall ducts and the burners.

The new turbine-generator is the steeple compound type, built by the General Electric Company, with a capacity of 110,000 kw. at 90 per cent power factor. The high-pressure element will be mounted above the low-pressure element and both will rotate at the common speed of 1,800 r.p.m. As high- and low-pressure sections will each be of the same capacity, namely 55,000 kw., their electric generators will be identically wound for the production of three-phase, 60-cycle alternating current at 13,800 volts. Each generator will be separately excited.

Vertical live-steam reheaters will be placed at either side of the unit to raise the temperature of the steam leaving the high-pressure turbine to 550 deg. F. before entering the low-pressure machine. A model of the turbine is here shown, although the final arrangements may be slightly modified. The greatest over-all length of the finished machine will be 61 ft. 4 in., and at the floor line this physical dimension will approximate 57 ft. 6 in. The maximum width of the turbine will be 21 ft. and of the generator 23 ft. Height from the floor line to the top of the control valve will be 20 ft. 10 in. The floor area occupied per kilowatt of rating will be 0.012 sq.ft. The net weight of the unit will be about 1,885,000 lb. The rotor of the high-pressure turbine will weigh about 31,500 lb. and the low-pressure turbine rotor 110,000 lb.

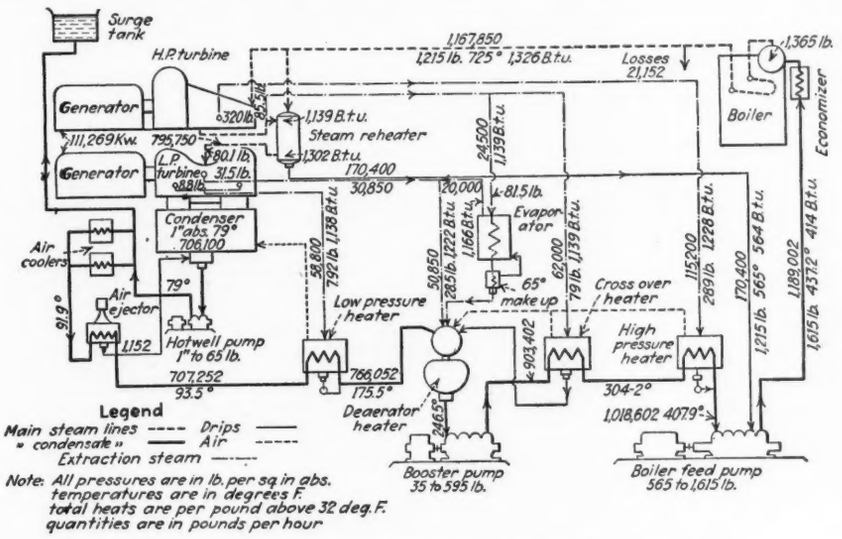


Sectional and plan views of boiler unit that will have maximum capacity to deliver 700,000 *lb. of steam per hour at* 1,350 *lb. pressure*

In the high-pressure turbine there will be twelve stages, the first of which will have a double-row wheel and the remaining stages single-row wheels. The low-pressure turbine will be of double-flow design, having ten stages on either side of a central steam admission. Provision is made to operate the low-pressure machine on live steam with the high-pressure element shut down, should this be required.

Both steam and water cycles are shown in the heat balance diagram. The steam pressure at the throttle is 1,215 lb. abs., and the temperature 725 deg. F. Exhaust from the high-pressure element will be reheated to a temperature of 550 deg. F. and delivered to the low-pressure machine at a pressure approximating 80 lb. abs. The low-pressure element will exhaust to a 77,000-sq.ft. surface condenser. Cooling water will have an average temperature of 59 deg. F. and will be brought to the plant from the Detroit River through a tunnel approximately 12,000 ft. long. This tunnel was described in *Power*, Sept. 17, 1929.

There will be four stages of bleeding to heat the feed-water, the first from the high-pressure turbine at 320 lb. abs.; the second from the crossover connection at 85 lb. abs.; the third from the low-pressure turbine at 31.5 lb. abs.; and the fourth from the low-pressure turbine at 8.8 lb. absolute.



Heat balance diagram for 110,000 *kw. unit*

As indicated in the heat-balance diagram, the condensate will be taken from the hot-well, forced through the air coolers of the generators, thence through air-ejector condensers and a low-pressure closed heater to a hot-water reservoir and open deaërating heater. Distilled water make-up will be delivered from a single-effect vertical evaporator at this point. It is probable, also, that treatment of the distilled water will be undertaken to eliminate all possibility of scale.

A booster pump having an operating range of 35 to 595 lb. abs. will take suction from the deaërating heater and force the boiler-feed supply through the crossover and high-pressure heaters to the boiler-feed pumps. The latter will have an operating range of 565 to 1,615 lb. abs. pressure to force the feed to the economizers at a temperature of approximately 437 deg. F.

The new unit is scheduled to go into operation early in 1930.

Maximum Thickness of Boiler Drums

IN ANSWER to discussion following the presentation of a paper, "High-Pressure Steam in the Paper Industry," J. B. Crane, Combustion Engineering Corporation, made the following statement concerning maximum thickness in boiler drum construction:

The limit for riveted drums is 2½ in. This requires a finished rivet about six inches long, which means that it must be about nine inches long before driving. The rivets are 1¾ in. in diameter and require a 200-ton bull for driving. To use plates thicker than this means that new equipment must be installed, which does not seem worth while, as equipment is already available for making forgings and welding drums above this thickness. By staggering tubes more metal can be obtained between the holes and in this way operate at higher pressures. Ordinarily, the holes are so close together that there is only 50 per cent of the metal between them and consequently the calculated thickness is to be doubled to carry the required pressure. By staggering the tubes 700 to 750 lb. pressure can be carried on riveted drums.

In making forged drums the shop takes a large ingot, punches a hole through it and turns the hole smooth to prevent cracks in the finished job. A mandrel is then put in the hole and the ingot is placed under a press with crane hooks around the mandrel at each end of the ingot. After each blow of the press the ingot is turned, and in this manner is forced out along the mandrel, enlarging the hole. As the hole becomes greater in diameter, larger mandrels are used until the required size for the drum is obtained. It costs approximately $3,000 each time the ingot is placed in the furnace to be heated, and therefore it is cheaper to use a large ingot in order to maintain the heat for forging. Consequently a drum 5 in. thick will have rough work with walls 8 in. thick, and this metal must be removed to make a finished job. It does not pay to use an ingot that makes a rough forging much less than 8 in. so that shells only 2½ to 3 in. thick must have over one-half the metal removed before being ready for use. After the drum is bored on the inside and turned on the outside to the required thickness, the ends are heated and placed under a press so that the heads are part of the finished shell.

In Germany there is a firm with a 2,000-ton horizontal draw bench which can extrude a drum up to 30 in. inside diameter, 5 in. thick and 20 ft. long. This can be delivered in this country for twelve to fourteen cents a pound, but most of our designs preclude a drum of this small diameter and short length.

A CORRECTION—In the power service equipment table for the New Yorker Hotel, Nov. 26 issue, the Spencer Engineering Company was credited as being the manufacturer of the pressure reducing valves. The correct name of this company is Spence Engineering Company, Inc.

LARGE GENERATOR LOSSES

Obtained at Full Load

By J. E. CALVERT
Power Engineering Department
Westinghouse Electric & Manufacturing Co.

Determining the load losses of large alternating-current generators with the armature short circuited has always left a doubt in engineers' minds as to how closely these tests checked with actual load conditions. A method is described that was used to test a 68,750-kva. turbine-generator at 80 per cent power factor load that gives a check on the short-circuit loading.

IN synchronous machines, the component losses under normal load conditions are frequently considered as: (1) friction and windage, consisting of bearing friction, air friction, fan loss introduced by the forced ventilating system; (2) no-load iron losses in the armature laminations, the rotor surface, the structural parts, in the end zones, etc.; (3) field-copper losses, which equal the field amperes times ring volts at the normal-load condition; (4) armature-copper losses, which are obtained by multiplying the armature current squared by the direct-current resistance of the winding; (5) load losses, or additional losses incident to load.

It is customary to determine the load loss of large alternating-current generators with the armature short-circuited, because this is about the only commercially practicable method of getting a nearly correct result. The method is predicated on the idea that these stray losses are in part composed of eddy losses in the armature copper, but primarily of eddy losses in the iron parts. It is thought that about the same flux pulsations will result due to the armature magnetomotive force under short-circuit as under load conditions, and that the difference in permeability due to the difference in the main flux will not greatly alter the losses.

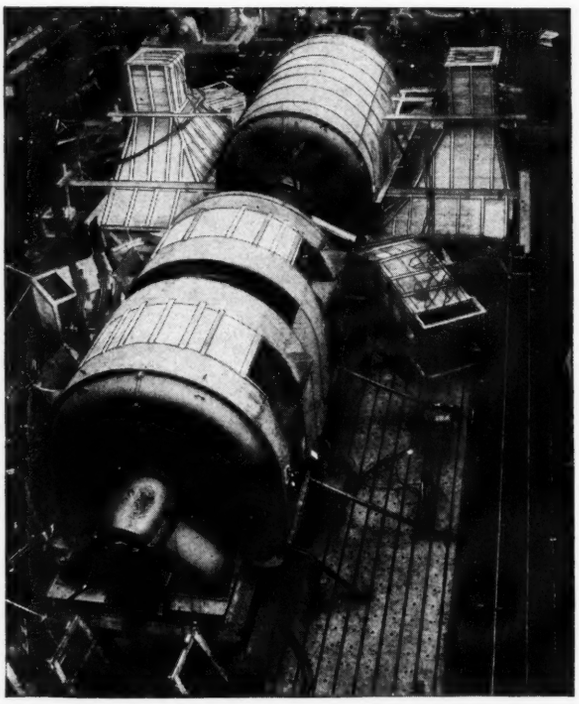


Fig. 1—Generators coupled together to make the load tests

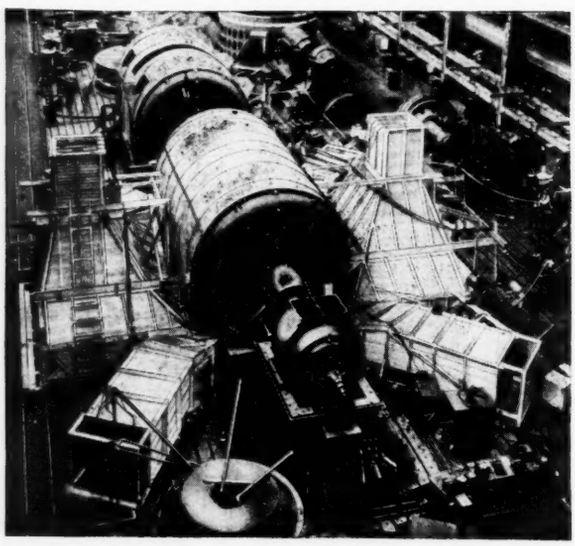


Fig. 2—Same as Fig. 1, but looking at the machines from the opposite end

Probably the most accurate way of determining the losses occurring within a turbine generator frame is by the calorimeter method, which is made possible by the system of ventilation used in the machines. A large volume of air is driven into the machine through definite inlets, and is discharged through one opening. There is practically no leakage between inlet and outlet. About 98 or 99 per cent of the losses occurring within the frame are carried away by this forced convection. Hence, if the weight and temperature rise of the air passing through the machine can be measured, the greater portion of the loss can be computed.

The remaining 1 or 2 per cent must be dissipated from the frame surface and shaft ends. This small part of the losses can be estimated fairly closely from the rise in temperature of these parts of the machine above the surrounding air, and the relative velocities of the air with respect to the dissipating surfaces.

This method of measuring losses takes into account everything but bearing friction, it being customary to mount the fan on the rotor shaft ends. It measures all of the load loss. Unfortunately, however, it involves more of a laboratory than a commercial type of test. It is necessary to allow the machine to reach constant temperature at every load, and it is necessary to make elaborate arrangements for obtaining reliable readings.

In recent years a number of these tests have been made at approximately zero per cent power factor: That is, a single machine has been operated as a motor, drawing only enough power to carry the losses and circulating full-load armature current at normal voltage, but at very low power factor. Most of the tests have been made at the overexcited condition, in which the machine draws a leading current from the line. A few have been made with the field underexcited and hence drawing a lagging armature current.

A number of these tests made in this country on machines of usual American design proportions have shown that the load loss, at the normal voltage zero per cent power factor overexcited conditions, was substantially the same as that measured on short-circuit. Yet there remains the possibility that some changes in the relative position of the stator and rotor magnetomotive forces at 80 per cent power factor might materially alter the load loss. It might increase the loss, and in that case the customer would not receive as efficient a machine for normal running conditions as he might expect from results obtained on the short-circuit test.

Calorimeter Test Requirements

It is difficult to meet all the requirements for a calorimeter test on a single generator at normal power factor. In a shop test the kilowatt load is not available. In the field, where the load and power factor can be obtained, the air ducts usually are not so arranged that reliable measurements can be made. It is hard to find any section in the air circuit where nearly uniform velocities obtain.

However, with two identical machines it is possible to couple them mechanically and electrically, and then obtain any load and power factor desired. Quite recently such a test was made on two 68,750-kva. turbine-generators. The losses of one were measured by the calorimeter method for various loads at the 80 per cent power factor overexcited condition.

The two turbine ends, or coupling ends, were joined together by an adjustable coupling, and the armature windings connected electrically, phase to phase, Fig. 3. Power was supplied partly from an electrical source and partly from a directly connected electric driving motor.

Considering the electrical connections first, it will be seen that power must flow in from the external source to the turbine motor. The motor transmits torque to

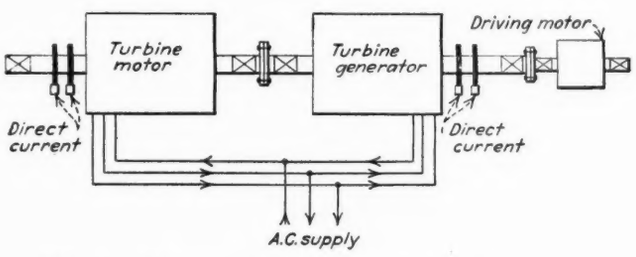


Fig. 3—Diagram of how the two generators were coupled together

the generator, which, in turn, supplies electrical energy to the motor. Thus the motor draws power from the line to assist in overcoming the losses of the two machines, and the generator delivers power to the motor approximately equal to the mechanical power delivered to the shaft by the motor. Full-load torque is maintained on the coupling. The small driving motor is used to deliver torque through the shaft, and hence to carry a part of the losses.

Concerning calorimeter tests, it is worthwhile to reflect briefly on the precautions that must be taken to insure good results. The heat in the air stream at the discharge from the generator must be proportional to each small mass of air times its actual temperature.

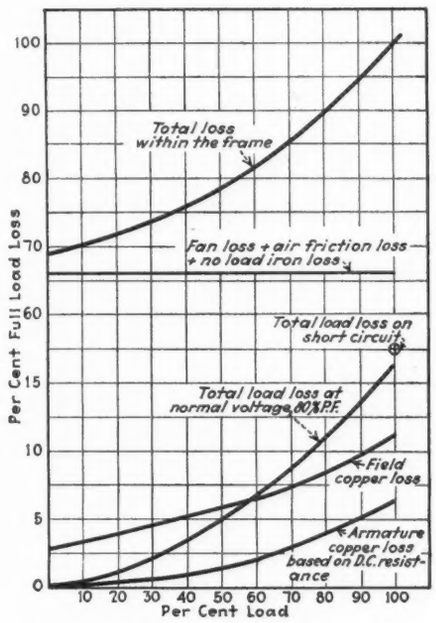


Fig. 4—Curves showing the losses expressed in terms of the total losses

Obviously, then, either the velocities or the temperatures should be evened out in order that one can average the factor that is variable and multiply it by the factor that is constant. This saves the process of multiplying a large number of small masses of air by their individual temperatures and summing them. It is most convenient to obtain nearly uniform air velocities at given cross-sections of the air streams, and hence nearly equal mass per unit time for equal divisions of the cross-section. To do this, air chutes were put on the four intakes, and two nozzles at the outlet end. These are shown in Figs. 1 and 2. These air passages were built of tongue and groove flooring, and all cracks and corners were caulked from the intakes to the discharges, and on the generator frame. The temperatures were measured at individual points over the intake and discharge sections. Thirty-six readings were made on the four intakes, and thirty-two on the two discharge sections.

Determining the Air Volume

The air volume was determined from the velocity pressure readings at the outlet or orifice at the top of the discharge ducts. At these portions of the air circuits, the static air pressures are practically the same as that of the room and the velocity pressure head can be read with a pitot tube and an ordinary U-tube opened to the room air at one end. Sixty-four readings were taken over the discharge area of each orifice on each load run, and the air volumes calculated. Temperature and barometric corrections were added in computing the mass of air passing through the machine per minute.

A check was obtained on the air test by means of electrical readings. Two runs were made with only one generator in operation, and driven entirely by the

small motor. The generator was open-circuited in each case, but excited for different voltages. This gave two values of loss within the frame. The input to the driving motor could be measured accurately and equated to the losses of the motor-generator and bearings, as follows:

Input to driving motor — motor loss = generator losses within frame + all bearing losses.

The motor losses were relatively small and could be computed accurately. If the bearing losses are assumed to be equal on the two runs, it may be written concerning the two tests that

Difference in motor output = difference in losses occurring within the generator frame.

The discrepancy in this check was of the order of 2 or 3 per cent. It is conceivable that the bearing loss might have contributed to this difference, if the oil volume varied, or the bearing temperatures differed appreciably on the two runs.

Fig 4 shows the segregated losses as determined by this method and expressed as percentages of the total loss. The load loss measured on short circuit is shown by a single point. The difference in the two methods is practically negligible.

The tests showed that for machines of this design, which one representative of those built by one of the large American manufacturers, the load-loss measured when circulating full-load armature current under short-circuit conditions is a fair measure of the load loss existing at the full-load normal voltage 80 per cent power factor condition.

Establishing Diesel Fuel Oil Standards

THE widely varying fuel oil specifications sponsored by the many Diesel builders has always been the cause of confusion and high fuel oil prices, because the refiner has had to make up comparatively small batches of oil to meet the requirements of an individual order. With the increase in number of Diesel engines, the difficulty has become costly to the engine user, who has been compelled to bear the extra refinery expense. That some method of standardizing such fuels into a limited number of grades was necessary, has been patent to all in the industry.

Through action by its Oil and Gas Power Division, the American Society of Mechanical Engineers appointed a special Research Committee on Diesel Fuel Oil Specifications, to study the subject and evolve specifications that would be acceptable to engine builders, oil refiners and engine users. The committee, although it has been functioning for less than two years, has prepared tentative specifications for two grades of Diesel oil. One grade is for heavy-duty slow-speed and the other for high-speed engines. The two specifications are as follows:

	Heavy Duty Engines	Light High Speed
Viscosity at 100 deg. F. Saybolt sec.	Max. 220 sec. Min.	100 sec. 45 sec.
Sulphur, per cent, maximum	3	2
Conradson, per cent, maximum	4	1
Ash, per cent, maximum	.08	.02
Flash, deg. F., minimum	150	150
Moisture and sediment, per cent	1	5

Samples of the heavy oil have been submitted to several engine builders, who have reported back the results obtained on the test floor. In addition, three engines were tested at the Navy Experimental Station. As it was impossible to fabricate the test oils so that the exact maximum specifications would be met in each particular, the committee decided that governing limit should be viscosity, which was set at 200 sec. at 200 deg. F. Consequently some of the oil samples had carbon in excess of the tentative specification requirements.

It was found that in the mechanical ejection engine, craters of carbon formed at the spray nozzle tips and the exhaust was smoky. In one case the nozzle was water-cooled, which reduced the smoke, and the performance with the heavy oil was as good as with light oil; save that it was more difficult to start the engine from a cold state.

In another shop the oil was used in precombustion engines. The exhaust was reported as being dark with a temperature of about 15 deg. higher than when the regular shop oil was used. Deposits on the nozzle orifice were found, while some soft carbon covered the piston crown. The oil was deemed unsatisfactory for universal use because of its high viscosity. When the oil was burned in a four-stroke-cycle air-injection engine, the exhaust at light loads was dark. When heated to 141 deg. F., the behavior was bettered but little.

At the Navy Experimental Station a 350-hp. M.A.N. mechanical-injection engine burned the oil satisfactorily when the oil temperature was raised to 145 deg. F. The chief difficulty with the cold oil was to get it to flow to and fill the fuel pump, by reason of the small passages. The results were considered as equal to that obtainable from "Navy Standard Diesel Fuel."

In addition, the station ran a test on a 50-kw. precombustion two-stroke-cycle engine. The results were considered satisfactory when the oil was heated to 140 deg. F., but better results are obtained with the Navy Standard oil. The station reported that the fuel oil will work on most American engines without heating, but for German engines, a more fluid oil is needed. The fact that a Cummins 50-hp., 850-r.p.m. engine will burn the oil without heating while a M.A.N. 350-hp. unit will not, is significant.

The committee, in its report to the Oil and Gas Power Division, concluded that the heavy grade oil will not work in all engines without heating, but announced that it was unwilling to accept this as final.

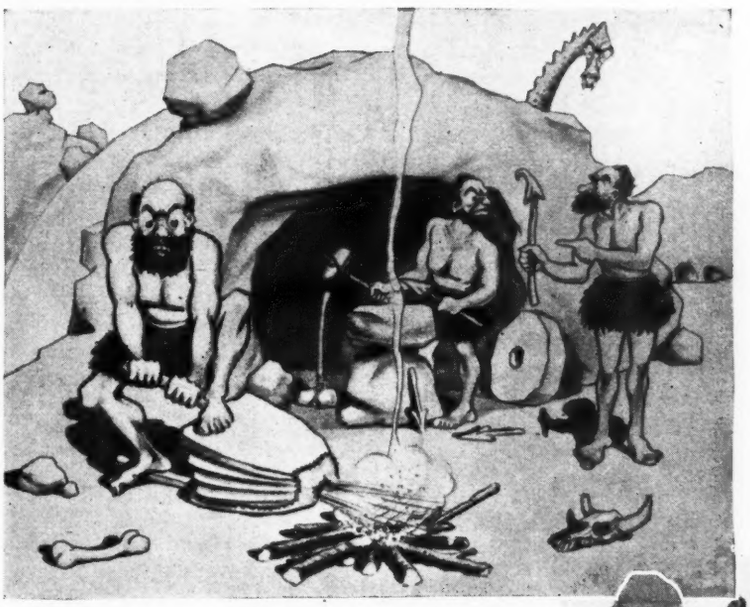
As a lowering of the Conradson per cent would increase the oil cost, the logical step is for the engine builders to alter their spray-nozzle designs so that the oil can be handled, heating it if necessary. The committee is proceeding with other tests in the endeavor to evolve a suitable standard. The light-oil specification offers no difficulties to the engine user, and will probably be adopted as now offered.

SMOKE COSTS $16 PER CAPITA—The Mellon Institute a few years ago placed the tangible damage done by smoke in Pittsburgh at $20 for each resident, and for the United States as a whole at $16 per capita. Another estimate places the annual cost of smoke and soot for a few large cities as follows: Cleveland, $6,000,000; Cincinnati, $8,000,000; Pittsburgh, $10,000,000; Chicago, $17,000,000; New York, $96,000,000. The city dwellers of New York State, including those in New York City, pay $178,000,000 every year as a penalty for the smoke and soot nuisance.

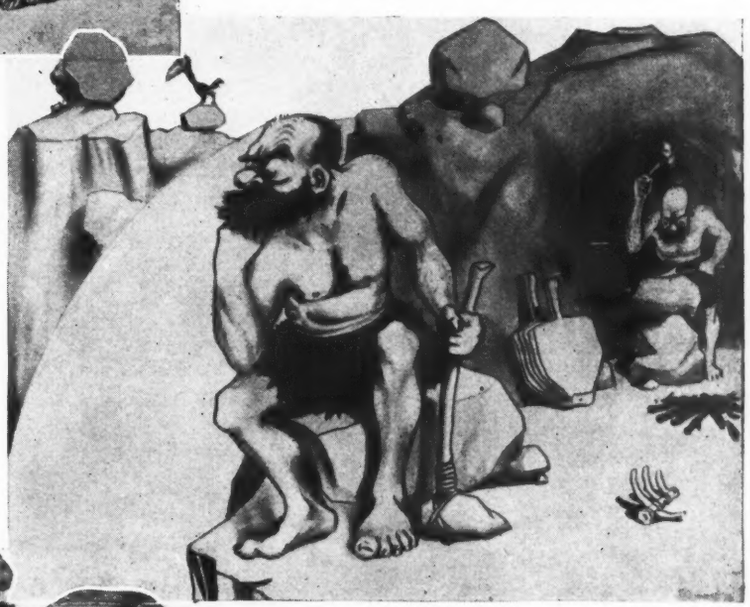
Prehistoric Power

Verse by
EDWARD SCOTT

Drawings by
J. RONAN



IN prehistoric years
When cave men forged their spears,
The blower was an "elbow-grease" affair;
And the cave man thus appointed
Had to work himself disjointed
To generate the necessary air.



The labor so terrific
Of this duty calorific
Caused hubbub in his primogenial knob.
At a cataractine brink
He scratched his chin to think
Of a method that would moderate the job.

After weeks of cogitation
There came the revelation
That the waterfall could serve to ease the strain.
So, while morons hollered, "Can't!"
He built a hydro plant.

MORAL:

No doubt it sometimes pays
to use your brain.

POWER *and* PROCESS STEAM Co-ordinated in Paper Mill

HIGHER BOILER PRESSURE ***and generation of current by turbine-generator unit bled to supply steam for drying and heating is the means by which large savings are anticipated over engine drive and the purchase of current for auxiliary power.***

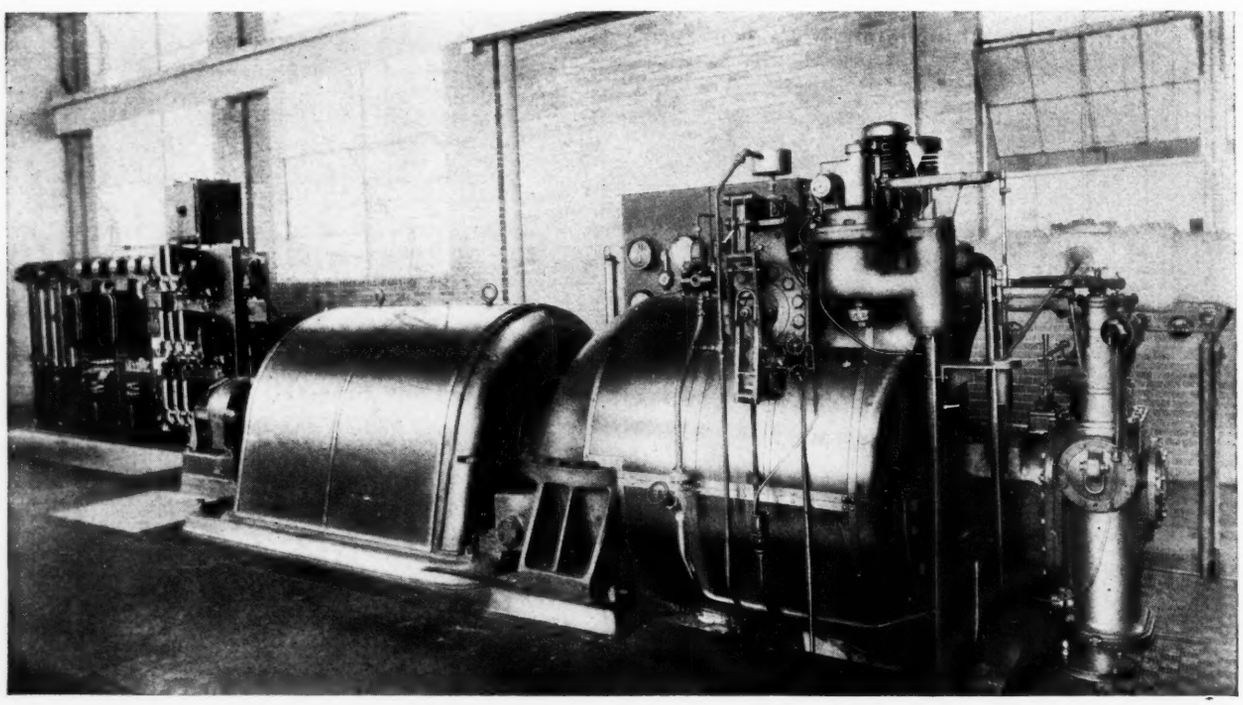
AT GREEN BAY, WIS., the Fort Howard Paper Company manufactures tissue papers exclusively and does not make pulp. The plant has been in operation for some ten years, with paper machines operated by steam engines exhausting into the paper dryers which to a large extent condense the steam. Auxiliary power used for the paper machines and in the finishing department was purchased from the central station under the condition of a steady load throughout the working week. During a great part of the year all of the exhaust steam from the machine drives was condensed, so that the plant was considered fairly economical. An engineering analysis, however, indicated that large savings could be effected by the installation of a modern plant that would co-ordinate more closely the power and process steam. Such a plant has been built. Under the new conditions power is generated for all services and sufficient steam is extracted under automatic control to supply the dryers and take care of the heating requirements.

A new boiler house was constructed and put into operation a little over a year ago to supplement four 72-in. horizontal return-tubular boilers, operating hand-fired at 140 lb. steam pressure. This building was put up clear of the old boiler equipment, leaving a space between the two boiler rooms in which a concrete stack was erected. The boiler room was built to contain two boilers. One was installed. Last winter a turbine building was constructed as an extension of the new boiler house. The equipment in this building was put into service in July.

In the turbine room the layout was made for two machines, the present 1,500-kw. condensing bleeder installation and a future turbine, probably of 2,500 kw. capacity. As the second large turbine probably will not be required for several years, its space is occupied temporarily by a non-condensing machine of 100 kw. capacity that is intended to carry the load of the plant on Sundays and at such times as the paper machines are not in operation.

The first boiler is of the bent-tube type, having 5,000 sq.ft. of heating surface and designed for operation at 325 lb. pressure. It is equipped with a convection superheater having sufficient surface to raise the steam temperature 150 deg. at 200 per cent rating. The plant load is approximately 35,000 lb. of steam per hour during mill operation.

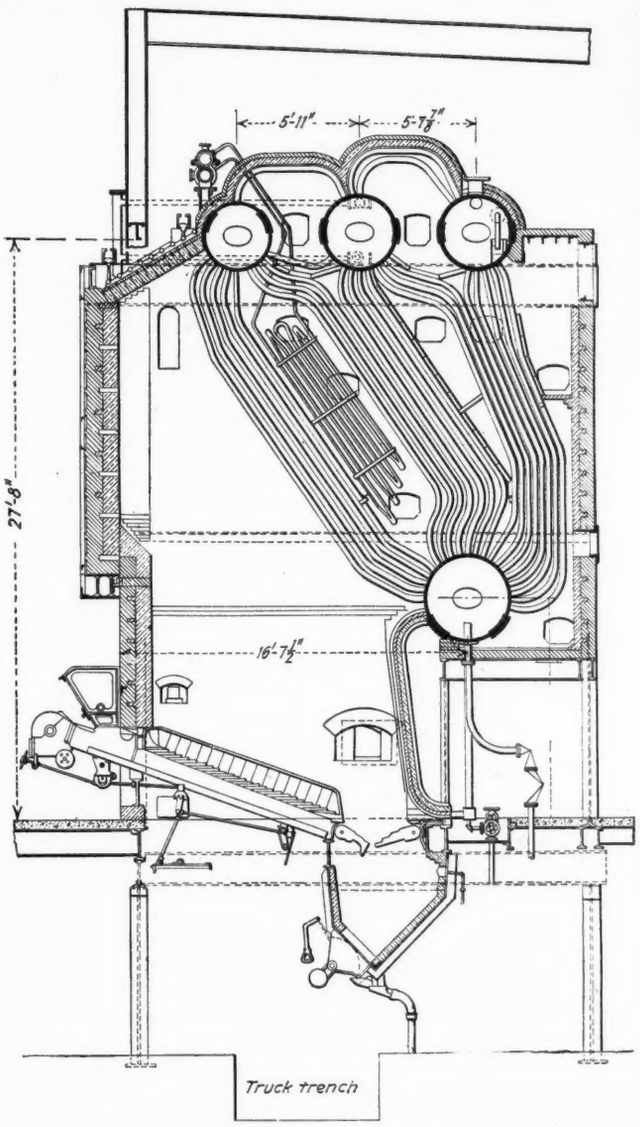
From the superheater steam is taken direct into the



Main 1,500-kw. turbine-generator unit, and, at left, paper machine control board

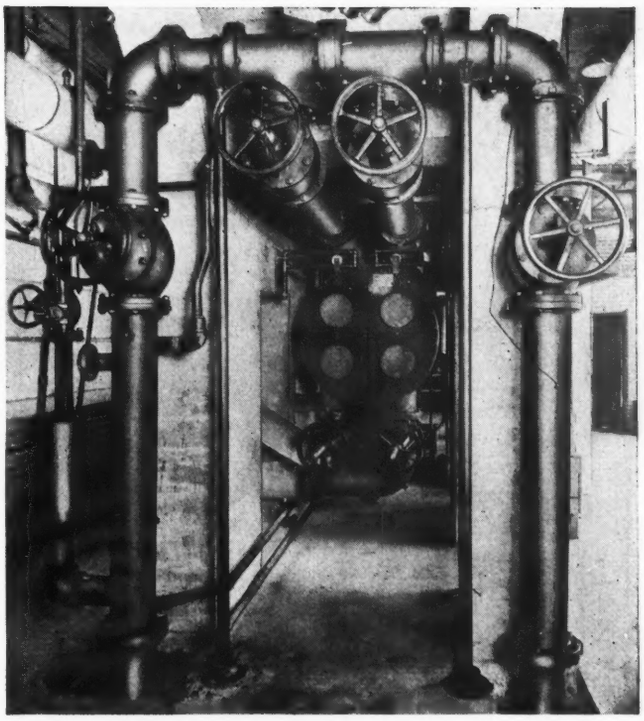
turbine throttle through a short run of piping, arranged at one end to receive steam from the second boiler and with provision in the basement of the turbine room for steam supply to another large turbine. The piping layout is simple, with provisions for expansion and drainage. The high-pressure piping system contains few fittings. All fittings and valves on the high-pressure line are of steel. All steel joints are lapped, made up without gaskets and with welded seals. Insulation consists of a 1-in. high-temperature covering followed by a 2-in. magnesia casing. On the high-pressure water piping Cranelap joints, male and female with gaskets, are used.

Shortly after the turbine was put into service a second boiler was purchased to be set in the boiler room in accordance with the original plan, with a view to taking care of future growth. This boiler will have 7,000 sq.ft. of surface and will be designed for a working pressure of 425 lb., with a superheater to give 600 deg. F. total temperature. This superheater and the one on the first boiler were laid out so that by the addition of elements a total temperature of 700 deg. can be obtained when required.



Vertical section through boiler unit

The new boiler has a furnace width of 11 ft. 6 in. and is equipped with a six-retort underfeed stoker that duplicates the first one, except that it has a greater furnace depth and an increased number of tuyeres. The second boiler unit is expected to go into service some time during February, 1930. Meanwhile the old horizontal return-tubular boilers are held in reserve, the main turbine having been designed for full-load operation under the lower steam conditions.



Condenser discharge piping in foreground with outlet to mill supply or to the sewer

Ordinarily, coal for the plant is received by boat and unloaded on a dock 100 yd. from the boiler house. A portable unloader puts this coal on a truck, which delivers at the foot of an elevator that raises the coal to a distributing screw at the top of the overhead bunker. Ashes are taken from the overhead bunker in which they are stored by the same truck that handles the coal.

Boiler feed consists largely of hot-well condensate and return water, which is passed through closed heaters to an open surge tank. Make-up is drawn from the raw-water supply and treated in a hot-process softening system. The feed pumps draw from the surge tank and force the water through a closed heater to the boilers.

Of the two boiler-feed pumps one is a turbine-driven centrifugal unit, while the other is a duplex reciprocating pump, either being capable of supplying the ultimate requirements of the plant. At the superheater inlet saturated steam is taken to supply these pumps and other auxiliaries. The centrifugal pump takes saturated steam at full boiler pressure, while the duplex pump and the other auxiliaries take steam through a reducing valve at 150-lb. pressure. Both pumps are controlled by governors operated by feed-water regulators.

The main turbine, taking superheated steam at boiler pressure, is of the extraction type. The bled steam is delivered to the paper mill through a 16-in. main at anywhere from 10 to 50 lb. gage pressure, according to requirements. The extraction steam is supplemented by the exhaust from the feed pump turbine. In addition to the mills, the extraction main supplies the closed heater directly and the low-pressure open heater of the water softener through a reducing valve. Exhaust from the tur-

bines driving the stokers also passes to the open heater.

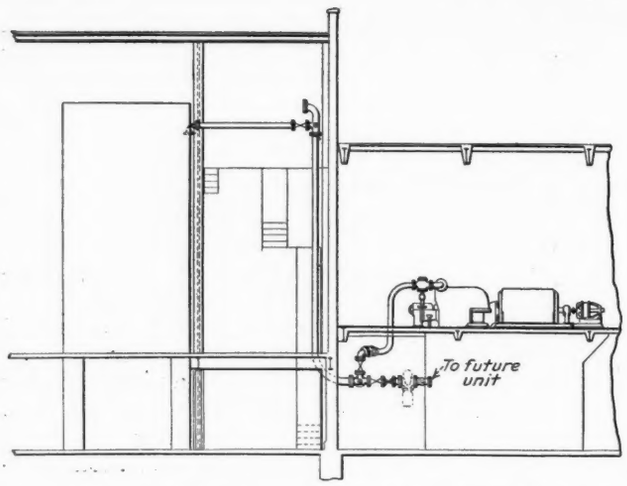
The non-condensing turbine takes its steam through a reducing valve at 200 lb. pressure. As this machine will be operating only when the boiler load is small, it will get no superheat except that due to the reduction in pressure. This unit also exhausts into the extraction line.

At 3,600 r.p.m. the main turbine drives a generator that delivers three-phase, 60-cycle current at 440 volts. The air cooler and the oil cooler are also supplied with water from the main circulating pump.

Condensing equipment comprises a surface condenser of the divided-water-box type designed to give 28 in. vacuum and, with 1,500 sq.ft. of surface, condense 15,000 lb. of steam per hour. Circulating and hot-well pumps are of the centrifugal type, induction-motor driven. Air is removed by standard steam-jet pumps with inter- and after-condenser.

The condenser water is taken from the general water supply of the mill. The piping has been arranged so that in the winter water from the condensers goes to the general mill supply, while in summer it is wasted.

Two motor drives have been provided for the paper machines. Each has a 200-hp., direct-current, variable-voltage motor. These motors take power from a pair of generators in the turbine room. The latter are directly driven by a 650-kva. synchronous motor. The main drive for each machine is through a gear set with an auxiliary drive from a pulley on the motor shaft. All auxiliary machines are driven by three-phase, 440-volt motors, some of the synchronous type and the remainder induction motors. From the direct-current generators to the motors, connections are made by lead-sheathed cables run underground to the mill center of distribution. The control panels for the paper machines, together with the automatic starter for the synchronous motor driving the direct-current generators, are located in the turbine room.



Simple piping layout from boiler to turbine

Principal Equipment in the Fort Howard Paper Company Plant

Boiler one, Casey Hedges, 5,000 sq.ft., 325 lb. pressure.....Combustion Eng. Corp.
One Stirling, 7,000 sq.ft., 425 lb. pressure, Babcock & Wilcox Co.
Superheaters, two 150 deg. F.....Superheater Company
Water screen, 120 sq.ft.....Combustion Eng. Corp.
Stokers, two, underfeed, 6-retort, 129.3 sq.ft. projected area, turbine drive, Westinghouse Elec. & Mfg. Co.
Feed-water heater, closed type, 135 sq.ft., Whitlock Coil Pipe Co.
Water softener, hot process.....Power Plant Spec. Co.
Feed pump, duplex, 12 x 6 x 15-in. Wilson-Snyder Mfg. Co.
Feed pump, centrifugal, 150 g.p.m., G. E. turbine drive .....Cameron (Ingersoll-Rand Co.)
Feed water regulators, "S-C".....Swartwout Co.
Combustion control .....Hagan Corp.
Coal-handling equip., bucket elevator, screw conveyor .....Jeffrey Mfg. Co.
Water columns .....Yarnall-Waring Co.
Blowoff valves .....Yarnall-Waring Co.
Non-return valves .....G. M. Davis Reg. Co.
Back-pressure valves .....Cochrane Corp.
Valves and fittings ..... Crane Co.
Insulation .....Federal Asbestos & Cork Insulation Co.
Steam fittings .....W. A. Pope
Turbine-generator, condensing, bleeder type, 1,500-kw., 3,600-r.p.m.; generator, 3-phase, 60-cycle, 440-volt, 2-pass air-cooler .....General Elec. Co.
Condenser, surface, 1,500 sq.ft. .....Foster-Wheeler Corp.
Circulating pump, 1,500 g.p.m., 16 ft. head, 1,200 r.p.m. —G. E. 10-hp. motor, Hot-well pump, 45 g.p.m., 65 ft. head, 1,800 r.p.m., G. E. 5-hp. motor Air pump, 2-stage, 2-element, inter- and after-condenser
Oil-filtering system .....S. F. Bowser & Co.
Turbine-generator, non-condensing, 100 kw. General Elec. Co.
Paper machine drives, two 200-hp., d.c., variable-voltage motors .....General Elec. Co.
Motor-generator, 650 kva. syn. motor, 2 d.c. 200-kw. generators .....General Elec. Co.
Paper machine control boards.....General Elec. Co.
Generator switchboards .....Marquette Elec. Sw. Bd. Co.
Indicating instruments.....Weston Elec. Instr. Corp.
Integrating and graphic instruments....General Elec. Co.
Circuit breakers .....I. T. E. Circuit Breaker Co.
Steam-flow meters .....Republic Flow Meters Co.
Feed-water meter .....Simplex Valve & Meter Co.
Pressure gages .....Foxboro Company
Thermometers .....Taylor Instrument Co's.
Structural work .....Wisconsin Bridge & Iron Co.
General building contract .....H. J. Selmer Co.
Consulting engineer .....W. L. Fergus & Co., Chicago

Low-Pressure Turbines In Steamships

THE FOLLOWING COMMENTS *on the application of low-pressure turbines to engine-driven ships are taken from a paper by J. H. King. This paper was presented at a meeting of the Society of Naval Architects and Marine Engineers, held in New York City, Nov. 14 and 15.*

THE principle involved in applying a low-pressure turbine consists in utilizing the energy contained in the exhaust steam from the low-pressure cylinder of a reciprocating engine by introducing it into a low-pressure turbine. The steam is exhausted from this turbine into the condenser at a high vacuum. Owing to the high expansion ratios the turbine can utilize, the low-pressure turbine is able to accomplish work that would not be practicable in the reciprocating engine because of the large cylinders that would be required. The use of the exhaust turbine in this fashion not only gives a very great increase in economy but also gives added power, resulting in an increase in speed, for the same initial expenditure of steam and fuel.

Several types of equipment using this general principle are now available. An installation of the Westinghouse system is now being made in the Susan V. Luckenbach, and the Bauer-Wach system is being installed in the Lena Luckenbach.

The Bauer-Wach system uses a double-reduction gearing arranged behind the reciprocating engine; a hydraulic clutch of Fottinger-Vulcan type is placed between the first and second reduction, and the main gear-wheel is mounted on a hollow shaft, which, together with the reciprocating engine shaft, forms a quill drive.

The Westinghouse system does not utilize the clutch, but provides an astern element in the turbine into which high-pressure steam is admitted during reversal.

A Model Specification For Gas Welded Piping

THE FOLLOWING SPECIFICATION *for piping fabricated by the oxy-acetylene welding process was prepared by the Linde Air Products Company and printed in its new booklet "Design Standards for Oxwelded Steel and Wrought Iron Piping." It is prepared in such a manner that it can be added to or incorporated in any general specification for a piping installation.*

1. These specifications apply to the welding design and welded construction of the specified piping system and are supplementary to and a part of the general specifications covering the installation. The general requirements, mechanical equipment and engineering features of the general specification and drawings are in no way affected by these welding specifications, which apply only to the substitution of oxy-acetylene welding for other types of joints in the specific piping. All work under the heading of "welding" is subject to the "general conditions" as written for the entire specification, which, insofar as they apply to this particular work, are understood to be herein repeated.

2. All piping, in general, shall be installed with welded joints unless otherwise directed by the architect or engineer.

3. All welded joints shall be made by the oxy-acetylene process.

Welding

4. All pipe shall be commercial grade of good weldable quality, free from defects, in the sizes and thickness required for the installation.

5. Welding rod for steel pipe welds shall be high test welding rod, equal to . . . or its approved equivalent. For bronze welds and brass pipe welds . . . welding rod and flux or their equivalent shall be used.

6. All welding shall be done by competent welders and in a thoroughly first class workmanlike manner.

7. The contractor shall be required to furnish proof of the competency of each welder or shall, at the request of the engineer or his representative, before any welding is done, furnish a specimen of a typical steel pipe line welded joint made by each welder in the presence of the engineer or his representative, jointing two 9-in. sections of pipe of the largest size to be welded in the installation (6-in. minimum size for these test welds). These shall be subjected to test by cutting into longitudinal strips 1 in. wide, so as to contain a portion of the weld, and at least four strips selected at random shall be gripped in a vise with the weld flush with the vise jaws and sledged until fracture occurs in the weld. The fractured weld shall show complete fusion to the bottom of the V and to the side, and sound weld metal, free from cold shuts, gas pockets or other defects. At the discretion of the engineers, standard A.S.T.M. tensile coupons, cut from the sample welded joint, may be subjected to tensile tests and shall show a minimum tensile strength of 45,000 lb. per sq.in. before permission is given for any welder to weld on the installation.

Line Joints

8. All line welds shall be of the single butt type for which the pipe shall be purchased, mill beveled or machine beveled to 45 deg. to within $\frac{1}{16}$ in. of the inside wall. Pipe with wall thickness $\frac{3}{16}$ in. or less need not be beveled, but may be welded by melting down into and building up over the abutting ends.

9. The abutting ends of the joints shall be separated before welding to permit complete fusion to the bottom without overlapping, tacked in two or more points to maintain alignment, and welded. All welding, wherever possible, shall be continuous around the pipe.

Butt Welds

10. All welds shall be of sound metal, thoroughly fused into the ends of the pipe and to the bottom of the V, and shall be built up in excess of the pipe wall to give a reinforcement of one-fourth the pipe wall thickness and in such a manner that the weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be $2\frac{1}{2}$ times the thickness of the pipe wall.

Fillet Welds

11. All fillet welds for flanges or fittings shall be fused into the pipe and plate for minimum distance of $1\frac{1}{2}$ times the pipe wall thickness and shall be built up to present a minimum throat thickness, or depth of weld, of $1\frac{1}{4}$ times the pipe wall thickness.

Welded Flanges

12. Standard flanges, if of cast or forged steel, shall be welded to the pipe at the back of the flange or by inserting or screwing the pipe within the flange to within $\frac{3}{8}$ in. of the face and welded both at the front and at the back. Special long-hub flanges designed for butt welding to the pipe, or welded flanges with a short stub, may be butt welded to the pipe where flanges are required.

Fittings

13. Tees, branch connections, swages, bends and other fittings, unless otherwise directed by the engineer, shall be fabricated by welding or designed to be welded into the piping system, provided such welded fittings are designed to give carefully matched intersections and are properly prepared for welding.

Anchors

14. Anchors shall be constructed of welded shapes welded to the pipe or of the design required by the engineer.

Gas Cutting

15. Fittings and odd lengths of pipe may be cut and prepared by the oxy-acetylene blowpipe, but all cut surfaces to be welded shall be regular and properly cleaned of all oxide by grinding, filling or other suitable method.

Testing

16. All welded piping operating at a working pressure in excess of 15 lb. shall be subjected to a hydrostatic test to $1\frac{1}{2}$ times the working pressure, at which pressure all welded joints shall be hammered with a 3-lb. hammer, the blows being struck with sufficient force to jar the pipe and joint but not so hard as to injure the piping. All welds shall satisfactorily pass this test without showing leaks or any defects.

All welded piping operating at 15 lb. or less shall be subjected to a suitable tightness test with air, steam or other medium, under which test all welds shall show no leaks or other defects.

TWO 8,100-HP. PUMPS S
POWER G

By PAUL L. HESLOP
New York City

These pumps are rated at 162,000,000 gal. per day, against a 240-ft. gross head. Before the final design of the pumps was decided on, extensive tests were made on models, as is done in waterwheel work. As a result of this careful design the efficiency of the pumps is exceptionally high, being over 90 per cent on test in place.

ON the Housatonic River near New Milford, Conn., is the Rocky River hydro-electric plant of the Connecticut Light and Power Co. This plant is the first in America to pump water for power generation. In general, the pumping is done when there is a surplus of hydro-electric power at other waterpower plants on the system and when required during off-peak loads on the steam system.

One 30,000-kva. hydro-electric generating unit and two pumps, the latter driven by 8,100-hp. synchronous motors, have been installed. The head on the units will vary from 200 to 230 ft., depending on the height of the water in the reservoir. The penstock and other waterways that connect the reservoir with the generating unit when the plant is supplying power to the system, serve to connect the pumps to the reservoir when water is being pumped. (See Fig. 4.)

At present there is one waterwheel, but another may be added. The center line of the pumps is placed about ten feet lower than that of the waterwheel. This saved foundation costs and permitted the use of the space above the pumps as a working and landing bay. The entire rotor, including the pump impeller, can be removed through the motor stator.

Near the discharge end of each pump is a 54-in. Dow disk arm pivot valve, opened and closed by penstock pressure in a hydraulic cylinder. The admission of water to the cylinder is governed by a solenoid-operated control valve in such a manner that current failure in the main pump-motor circuit de-energizes the solenoid and automatically causes the valve to close.

Each of the two pumping units has a capacity of 112,500 gal. per min., or 162,000,000 gal. per day against a gross head of 240 ft. They are of the vertical-shaft, single-inlet, single-stage, bottom-suction volute type, Fig. 5. The driving motor is mounted rigidly on top of the pump casing, being supported thereon by a cylindrical distance ring. They are General Electric synchronous motors, rated at 7,900 kva., 0.80 leading power factor, 13,200 volts, and run at 327 revolutions per minute.

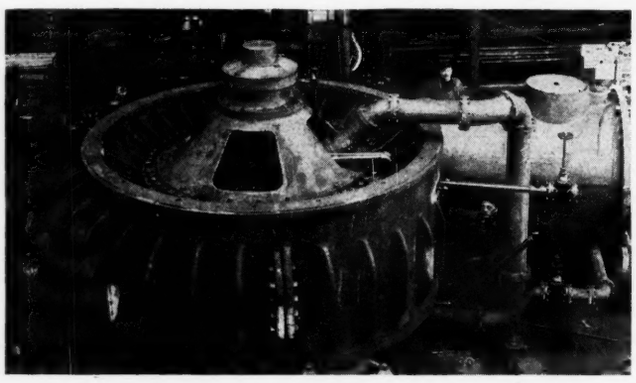


Fig. 2—Pump casing of volute type designed without diffusion rings or staybolts

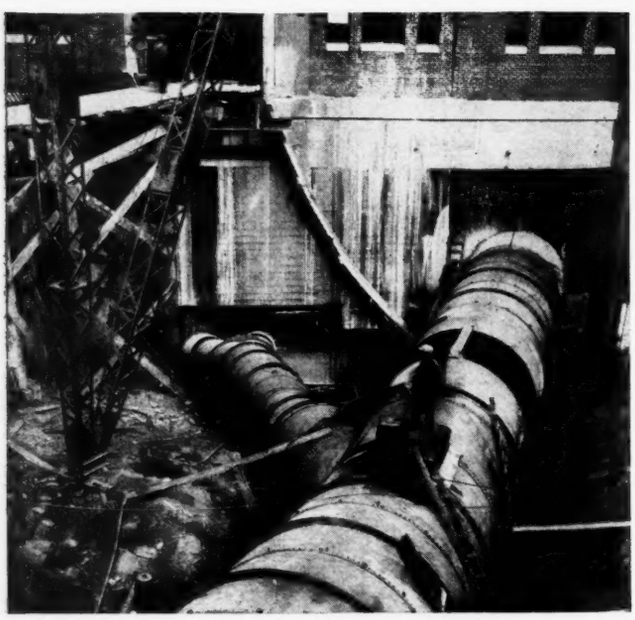


Fig. 1—The rear of the power house, showing the pump connection into the penstock

The pumps were designed and built by the Worthington Pump & Machinery Corporation. Close cooperation between pump and motor manufacturers resulted in a compact and simple unit on a common shaft for the pump and motor without a coupling. Only one lower guide bearing and one upper combined Kingsbury guide and thrust bearing are required for the entire unit.

These pumping units are pioneers in their class and are the highest power single centrifugal units in America, being the largest high-head pumps of any type in this country. It is interesting, therefore, to know the reasons that prompted the pump builders to propose and adopt this type of pump.

High pump efficiencies being one of the prime requisites of economical operation, the pump builder decided

SUPPLY WATER FOR GENERATION

Fig. 3 (Above)—Impeller for one of the pumps

*Fig. 4 (Left)—*A *is the dam at the lower end of the reservoir,* B *the intake tower and* C *the surge tank at the upper end of the penstock leading down to the power house*

to use a volute form of discharge casing, without diffusion rings, which might have acted as staybolts to give the casing additional stiffness. Instead, a cylindrical ring of considerable depth, with a large number of stiffening ribs, was made a part of the casing. The importance of this precaution can be seen in the fact that an internal pressure of 1,260,000 lb. tends to deflect or separate the casing and heads.

It was decided to use the highest speed consistent with efficiency and freedom from cavitation, with the higher speeds the dimensions of the unit, and thereby the internal stresses, being reduced. Coincident with these advantages, the vertical setting made it possible to accommodate the unit in a minimum floor space.

It was essential to select a practical form of suction approach that would allow the pump to fill uniformly, attain high efficiency and not impose undue hardship in the construction of the foundation for the units.

Before work on construction of these pumps was started a model pump, in the ratio of 1 to 5.34, was constructed and tested to determine the factors influencing performance, cavitation, form of suction approach and minimum clearance in the impeller bushing rings to guarantee satisfactory operation at such times the pumps would be called to run dry for power-factor correction. This model pump was tested with three impellers and two forms of suction approach with various clearances in the pump. Altogether, tests with twelve different arrangements and impeller combinations were conducted. From these what appeared to be the best combination was selected as a basis for the final design.

It was recognized that for a model test to be of value, the model would have to be run at a speed as many times greater as it was geometrically smaller than the large pump, thereby operating over the same range of heads and showing the peculiarities of cavitation, noise, vibration and other phenomena encountered in high-head centrifugal pumps.

The pump casings are below the suction-water level. For electrical reasons the pumps are started up dry by admitting compressed air to depress the suction level. After the unit is brought up to speed the compressed air is released, allowing the water to fill the impeller and pump casing. Then the discharge valve is opened and the pumping operation commences.

It is of interest to note the similarity in appearance between the Rocky River pumping units and a hydro generating unit of the same physical size. In outward appearance, it is impossible to distinguish between them. The suction elbow shown in the cross-section, Fig. 5, resembles the draft tube of a waterwheel.

In general, pumps have not reached the efficiency of waterwheels, nor has as much experimental work been done with pump settings as with waterwheels settings.

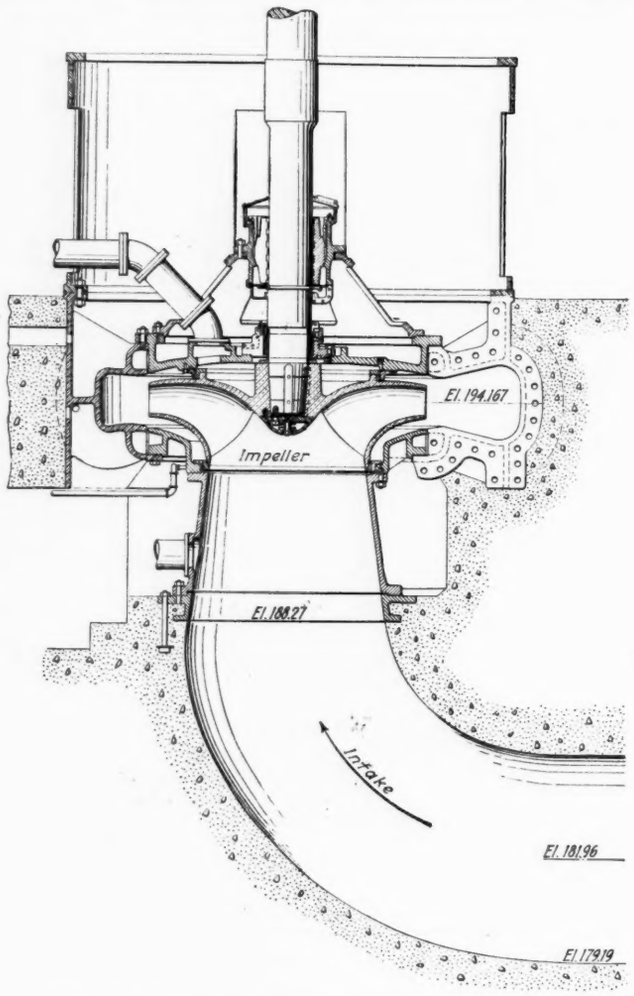


Fig. 5—Cross-section of one of the two pumps

Note the close resemblance between this cross-section and that of a waterwheel and its draft tube.

It may not be a mere accident that the Rocky River pumps so resemble turbines of similar size.

The pumps have cast-steel casings made in five sections. Each casing weighs 70,000 lb. There are no struts, such as used in large water turbines, in the waterway for stiffening the casings. The casings are provided with outside ribs to prevent their breathing, which would affect the alignment of the bearings and the running joints in the wearing rings.

The impeller is made of a special composition bronze to resist action of the water. It weighs 11,000 lb. Steel wearing rings on the impeller and bronze on the steel casing were selected with special regard for operating with small clearances without seizing. Water under pressure is supplied to lubricate the wearing rings at the time of starting or when the pumps are operating dry for power-factor correction.

Each pumping unit is provided with two motor-driven oil pumps. One of these pumps is electrically interlocked so that it must start before current is applied to the main motor, and also stops when the main current is cut off. The other oil pump is arranged to go into action automatically upon either mechanical or electrical failure of the first. The oil pump supplies oil to the bearing of the main pump and also to the Kingsbury thrust bearing of the motor, there being but one oiling system for each complete pumping unit. Each oiling system is provided with a sump and storage tank, sight-flow indicators with electrical alarm connections, duplex

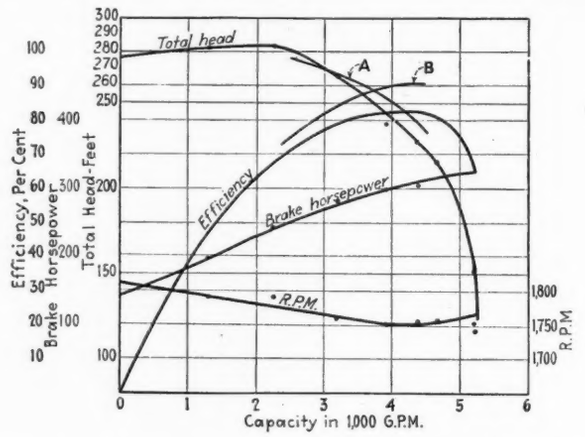


Fig. 6—Curves obtained from the test made on a model pump

A and *B* are efficiency and head curves obtained from pump No. 1 tested in place.

strainer, pressure gage and cooling coils, the latter being within the thrust-bearing housing.

The pumps have been tested in place using the Allen salt velocity method for measuring the water. The results of these tests are shown on the curve Fig. 7. The maximum efficiency for pump No. 1 was found to be 91.7 per cent at 238.84 ft. dynamic head, 279.5 cu.ft. per second discharge and 8,259 shaft horsepower. Pump No. 2 was not tested for maximum efficiency.

With the Dow valve wide open, pump No. 1 showed an efficiency of 90.1 per cent at 228.35 ft. dynamic head, 292.7 cu.ft. per second discharge, and 8,416 shaft

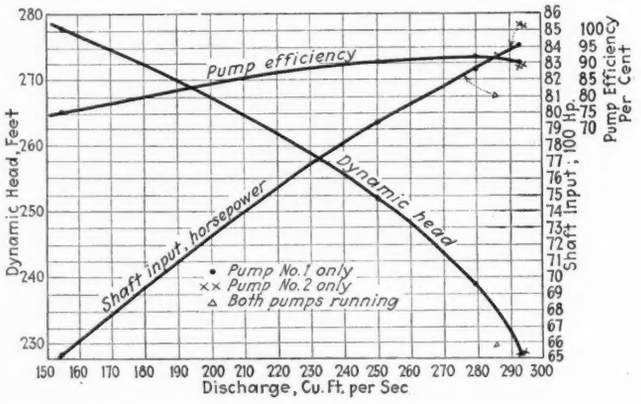


Fig. 7—Curves obtained from testing the pumps in place

horsepower. The efficiency of pump No. 2 with the Dow valve wide open was 89.4 per cent at 228.59 ft. dynamic head, 293.7 cu.ft. per second discharge and 8,522 shaft horsepower. Tested together, with both Dow valves open, the pump efficiency was 91.9 per cent at 229.67 ft. dynamic head, 571.6 cu.ft. per second discharge and 16,216 shaft horsepower.

Right Out of the Plant

Tempering Slack Coal

EVERY engineer who has had to burn slack coal on a chain-grate stoker knows how hard it is to keep an even fire if the coal is dry. And almost everyone has tried some way to wet the coal, but it is not so easy to do. However, we found a method that works fairly well and might be of interest to others.

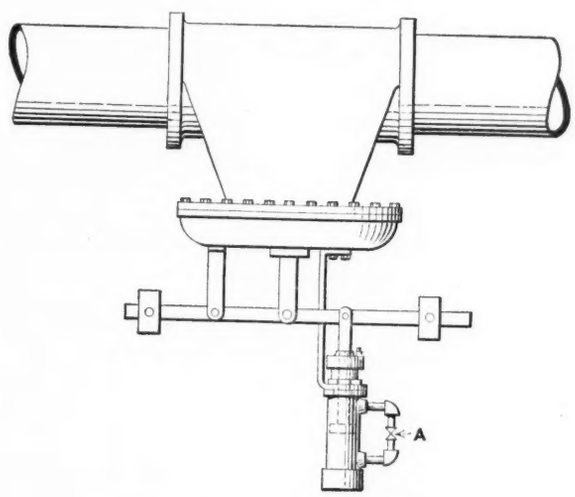
We have an overhead coal bunker that holds about four days' supply. The coal is elevated into it with a bucket elevator that discharges through a spout. We installed an ordinary lawn spray nozzle in the end of the spout so that the water plays over the entire stream of coal and cone beneath. It took a little practice on the part of the coal man to get just the right amount of water, but when this is set the mixture is the same as long as the elevator is kept running at its full capacity.

This system works much better than trying to wet the coal in the weigh larry or in the stoker hopper, because it is more uniform. The fact that the coal stands from one to four days allows any excess moisture to seep away. Being drawn from the bottom of the bin, the coal is continually agitated and there is no chance of its heating and causing spontaneous combustion.

Butte, Mont. A. D. FORD.

Dashpot Improves Operation of Reducing Valve

IN THE steam power plant where I am employed we have several reducing valves that are used for different pressures. We have experienced no trouble with them excepting one on the heating system. When our turbine is running we have sufficient exhaust steam to heat the building, but when the turbine is shut down we have to use live steam through the reducing valve for that purpose. This reducing valve opened and closed very quickly, and causing wide fluctuations in the boiler load.



Reducing valve with dashpot attached

To eliminate this trouble we made a dashpot as shown in the illustration, which is self-explanatory. The cylinder is made of $2\frac{1}{2}$-in. brass pipe with a cap on each end. The upper cap was drilled and fitted with a stuffing box and also a filling plug. The upper end of the cylinder is threaded long enough for two lock nuts, one on each side of the bracket, as shown.

The working of the dashpot is as follows: The cylinder is partly filled with oil. When the steam pressure drops the main valve is opened by the action of the diaphragm. The lever is moved upward, carrying with it the piston in the cylinder. On the up stroke the piston forces the oil out of the upper end of the pipe through the bypass to the lower end. The quarter-turn cock *A* is adjusted so as to retard the flow of oil, thus causing the valve to open and close much slower than it did before the dashpot was added. The valve can be made to open or close at the speed desired by adjusting the cock *A*.

N. Cambridge, Mass. W. A. DOW.

Why the Motor Winding Burned Out

SOMETIME ago a squirrel cage motor failed through one of the stator windings burning out. The motor was a 20-hp., 3-phase, delta-wound machine. It was started by a star-delta switch and was protected by a circuit breaker fitted with a no-voltage coil and two overload coils, the trips being set to operate at 120 per cent overload without a time lag.

This motor had been started as usual and had been running sometime when it suddenly stopped. On examination one of the phase windings was found to be burned out. The cause of the breakdown was found to be due to an open circuit in the starter. This had caused the motor to run as a single-phase machine, one winding working in parallel with the other two in series.

In the case of a delta-wound machine of this size, the current passing through the phase winding connected singly across the line would be about twice full-load current. This would be insufficient to operate the circuit breaker, set at 120 per cent overload.

To guard against accidents of this sort the circuit breaker should be set to operate when the full-load current is exceeded by 25 per cent or more. Had the breaker been set in this way in the present case the breakdown would have been avoided.

As the current at starting would greatly exceed the full load current, if the breaker were set so close, it would open each time the motor was started, as well as during momentary overloads. This could of course be prevented by suitable time lags. An alternate method is to arrange for the circuit breaker to only be in circuit while the motor is running. During starting, the motor is protected by fuses, arrangements being made to cut them out of circuit when the motor reaches full speed.

Brighton, England. W. E. WARNER.

Pointers on Balancing Pulleys

THE article on pulley balancing, by W. D. Campbell, in the Nov. 5 number of *Power,* recalls a case of countershaft vibration that I encountered some time ago. An engine lathe of the bench type was mounted on wheels for portability, with the countershaft and motor on the same wood frame, to form a unit. Flexibility of the wood frame was conducive to vibration, the outfit having a natural lateral vibration of 300 per minute, which was also the countershaft speed.

The countershaft had two clutch pulleys, one of which was belted to the motor, the other not used. The machine vibrated in a way that made it hard to see the graduations for close work. It would occur intermittently, with a rough period about once a minute, followed by a few seconds of smooth running. It was clear there was no relation to spindle speed, or unbalance of the work.

The trouble was finally traced to the clutch pulleys, both of which had turned faces, with internal surfaces left rough, each with a thick side. The intermittent tendency was caused by the free pulley, which turned with the shaft at slightly lower speed, since its bearing clearance allowed it to roll in the manner of an oil ring, losing one revolution a minute. When the heavy sides of the pulleys were together, vibration was severe, while they ran smoothly when the free pulley had dropped back half a turn.

The most convenient method of balancing we could find was to chuck each pulley in the lathe, and turn off the heavy side, which made a fair balance, then finish by drilling. The clutch parts and cone pulley, were also balanced, and all vibration disappeared.

Lenover, Pa. G. BOYD.

Calcium Carbonate in Boiler Water

IN THE Dec. 3 number of *Power* there was a question in regard to the causes for a condensation of calcium carbonate in steam traps, giving details, etc.

To this have been given three answers. The first and third by Raymond F. Forbes and J. A. Holmes, respectively, are, in my opinion logical and uninvolved. The answer by Charles Dick is based upon a rather interesting theory, but certain of his contentions cannot be anything else but theories that can hardly be proved.

Mr. Dick states that the steam, as *dry* vapor, carries with it calcium carbonate in the form of calcium oxide and CO_2. Of course, it has not been stated in the question whether the plant used superheated steam, but even if superheated steam is used, it will take little time before the steam ceases to be dry, in which case the calcium oxide would become calcium hydroxide in the relationship of 56 of CaO to 18 of H_2O. At the high temperatures prevailing in a steam plant of even only semi-modern design the calcium hydrate would be nothing else but a precipitate carried along with the steam, as was stated in the other two answers.

The condensation of the calcium hydrate (not calcium oxide) in the traps will follow the formula:

$$Ca(OH)_2 + CO_2 - CaCO_3 + H_2O.$$

Generally speaking, the whole thing is more a simple carrying over process than it is a matter of condensation.

To throw some further light on the situation I would refer the reader to Thorpe's Dictionary of Chemistry 1921 Vol. 1—page 732, which gives the tension of dissociation of $CaCO_3$ as 27 mm. at 547 deg. C. (1,016 deg. F.) and 753 mm. at 812 deg. C. (1,493 deg. F.). Even the 27 mm. at 1,016 deg. F. would mean that very little of the $CaCO_3$ would be dissociated. Also on page 735 of the same volume it states that $Ca(OH)_2$ is decomposed at a red heat into CaO and H_2O.

I think these references will answer the question fully. It is difficult to imagine any involved chemical condition due to the presence of dry steam affecting these reactions.

J. H. GULLAK, *President,*
New York City. J. H. Gullak & Co., Inc.

Blowing Soot With High-Pressure Steam

FROM the discussions that have appeared in *Power* from time to time on the care and operation of soot blowers it is evident that some engineers are still of the opinion that there is no danger of damaging boiler tubes if 200-lb. steam pressure is used for soot blowers. Our experience, however, has proved otherwise.

Our plant consists of two bent-tube boilers operating at 150 lb. pressure and equipped with the required number of blower elements. The boilers have been in use about six years and sometime ago a tube developed a leak and had to be renewed. An investigation showed that one of the blower elements had slipped out of place about $\frac{3}{4}$ in., or else had been set that way originally. This allowed the steam to impinge upon the side of the tubes and seven of them were grooved as neatly as it could have been done with a file.

Since the elements generally have to be set in the most inaccessible places in order to accomplish their purpose, it is a good plan to inspect them at regular intervals; particularly if high-pressure steam is used.

Helena, Mont. A. D. DUNCAN.

Why Does A Boiler Roar?

IT IS a well-known fact that steam boilers and locomotives sometimes roar at a definite load. The boiler then emits a deep sound which is objectionable. But this is not all! Boiler fittings, the windows of the boiler house and other pieces of equipment sometimes participate in the vibrations and this resonance causes increased wear and tear.

A sound always presupposes the presence of a vibrating medium. It is likewise known that in the case of a roaring boiler this medium consists of oscillating gas volumes. Since this sound is strong the column of gas must be thick, and since the sound is deep the column must be long, because the frequency of an oscillating gas column is inversely proportional to its length.

In a boiler there generally exists but one gas column that conforms with these conditions. In a stoker-fired boiler, for instance, it is formed by the gases which fill the space above the grate up to the top of the boiler. This is generally acknowledged as correct.

To eliminate the roaring of the boiler it is, however, not sufficient to know which column of gas vibrates but it is essential to know why it vibrates.

For this fact there exists quite a number of explanations the most prevalent of which may be explained by the following example: A chain-grate, stoker-fired boiler with a large combustion chamber and a fairly long refractory arch, that opens into the combustion chamber with a sharp edge, roars at a definite output and when a definite size of coal is used. If coal of a larger size

is used in the furnace, the roaring very soon stops.

An explanation of this is that because an insufficient quantity of air can pass through the front portion of the grate an excess of gas develops over the front half of the grate and an excess of air above the rear half. In consequence, a further mixing of the gases with the air takes place later causing a secondary combustion of volatile gases below and between the water tubes. This combustion being of the nature of slight explosions gives the impulse for the sounding vibrations. One point against this theory is that these explosions, if they happen at all, will not occur with a regular frequency, but will occur irregularly and impart small shocks to the column of gas at irregular intervals. This is obviously insufficient to cause a continuous oscillation.

Another explanation is that the development of an oscillation is assumed to be due to the existence of periodic shocks of a frequency equal to the frequency of the gas column. But first there exist only uniformly operating forces in the flow. It is therefore necessary that such a force be decomposed somewhere into a periodically acting force. But where does this happen?

The fresh fuel is rapidly distilled under the refractory arch of the boiler. The hot burning gases escape from under the refractory arch and enter the combustion chamber. A sharp reversal of the direction of the flow then takes place at the edge of the arch. If the direction of a flow is changed by such an obstacle, an eddy space is set up. Those eddies which have moved away farthest from the obstacle detach themselves at certain intervals and float away.

This is shown in a number of instructive illustrations by Thoma in Fig. 16 of his book, "Hochleistungskessel," (published in 1921 by Julius Springer, Berlin), and by Nippert in his paper, "Ueber den Strömungsverlust in gekrümmten Kanälen," in Figs. 5, 6, 8, 11, 14, 16, 19, 20, 27 and others (published in 1929 by the V.D.I.-Verlag).

Karman and Rubach have shown that eddies developed behind a cylindrical shaped obstacle move away periodically (Physikalische Zeitschrift, 1912). The number of the eddies moving away per second increase with the growing velocity of the flow. They have in this way explained the singing of the telegraph wire and the sound produced by a stick moved quickly through the air.

It is therefore probable that eddies forming behind an edge—for example the edge of a refractory arch—and moving away, likewise move away periodically. This moving away is still further promoted here by the buoyancy of the hot gases. Every eddy moving away causes a light shock. At a definite velocity of the gas below the arch, that is at a definite output of the boiler and with a definite fuel, the number of the eddies formed at and moved away from the edge of the arch is equal to the natural number of oscillations of the gas column. The column, therefore, begins to oscillate in resonance and the boiler roars.

That this theory holds true is confirmed by the fact that the oscillation does not happen if a better coal is burned under the boiler. The larger size coal gives less gas, a lower gas velocity under the refractory arch and fewer eddy shocks per second.

It is improbable that the dangerous source of the shocks is in the eddies moving away behind the water and superheater tubes, since these light shocks take place across the entire boiler width irregularly due to the different velocities of the gas, and the oscillations do not occur when another size of coal is fired at the same output of the boiler. But whether the gas column above the grate or any other oscillates, or whether perhaps all gases oscillate is immaterial. The problem is to find the source of the shocks and to eliminate it.

If the foregoing prediction that the moving away of the eddies behind the edge of the arch is the cause of the roaring, is correct, then the edge of the arch would have to be constructed so that a moving away of the flow from the wall, and thus the formation of eddies, would be eliminated. The arch might also be placed higher, or more or less air might be admitted to the first portion of the grate to alter the velocity of the gas underneath the arch. The latter provision, however, would not have to interfere with an economical combustion.

An entirely satisfactory explanation for the roaring of boilers, generally admitted as correct, does not exist, and I wish the foregoing to be understood as another attempt to explain this peculiar phenomenon.

Berlin, Germany.

F. MICHEL.

New Orleans' Mammoth Pumps

IN THE Sept. 3 number of *Power* there was a brief description and photograph of one of the new pumps being installed by the Sewerage and Water Board of the city of New Orleans, La.

In this article it was stated that "As New Orleans is below sea level, some artificial means must be provided for getting rid of the surface water, which in other cities drains away naturally."

I should like to point out that, contrary to the general impression in the North, the city of New Orleans is not below sea level. As a matter of fact the average elevation is about five feet above sea level. The city, however, is below the level of the Mississippi River at flood stages, hence the necessity for levees.

The reason for the large pumps described in the article is that the city is built on comparatively level ground, and natural drainage is inadequate.

New Orleans, La. CHAS. P. WHITTY.

Why Flanged Pipe Joints Leak

In the Nov. 12 number of *Power*, J. E. Noble commenting on my letter in the Oct. 22 number, infers I would have readers believe "that joints made with thick flexible metallic gaskets will remain tight under expansion and contraction stresses and that a thin gasket is more likely to leak." He says that provision for expansion must be made at places other than at the flanged joints.

The original article, which I criticized, pertained only to joints. Nothing at all was said about expansion and contraction problems in the pipe line proper. What Mr. Noble says is correct—one cannot expect a thick flexible metallic gasket to take care of all of the expansion and contraction in a pipe line. My contention is that a first-class thick flexible metallic gasket will take care of the expansion and contraction stresses within the joint itself. Pipe bends or expansion joints are necessary in many pipe lines to take care of over-all expansion and contraction.

Newark, N. J. W. F. SCHAPHORST.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Self-Contained, Air-Cooled, Two-Stage Air Compressor

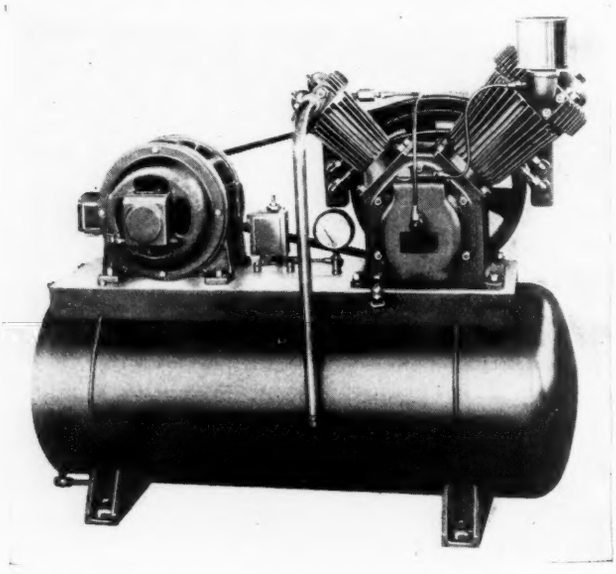
BUILT for working pressures up to 200 lb. continuous duty, the new line of air-cooled, two-stage air compressors (type 30) announced by the Ingersoll-Rand Company, 11 Broadway, New York, is put out in four sizes, ¾, 1½, 3 and 5 horsepower.

The units are self-contained, the motor and compressor being mounted on a steel base, which is attached to the top of the air receiver. With this arrangement, no special foundation is required for correct alignment of the compressor and motor. The intercooler, which consists of three curved copper tubes with extended surfaces, is located behind the fan-type flywheel, and a constant current of circulating air is driven directly across the cooling coils. No water is used for cooling.

Automatic start and stop control, furnished as standard equipment, operates independently but in conjunction with the unloader. When the pressure in the air receiver reaches a point at which the regulator is set to unload, the motor is automatically shut off as the machine comes to rest. A centrifugal governor mounted on the end of the crankshaft allows the air in the high-pressure cylinder and intercooler to exhaust through the crankcase. This prevents the compressor from starting against a load. To reduce the oil in the discharge air to a negligible quantity, each piston is fitted with two oil-control rings, the cylinders are honed and each piston is run into its respective cylinder.

Both motor and compressor are fitted with ball bearings. A V-type belt drive is used. The compressor is entirely inclosed, with the base forming a reservoir for oil, no oil pump is employed. A bayonet gage serves to show the amount of oil in the reservoir.

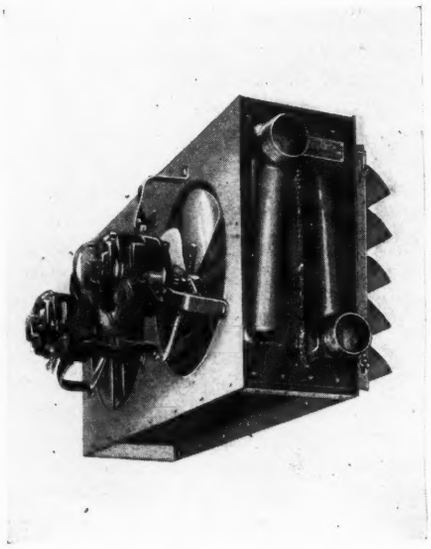
The employment of the standard I-R plate valves, bronze connecting rod with solid ends, full floating piston pin with bronze bushings, balanced crankshaft and a self-cleaning air filter are some of the important features of the new unit.



Complete self-contained air-compressor unit

Unit Heater in Five Sizes

BUILT in the single- and duplex-fan types, the unit heater illustrated, put out by the United States Radiator Corporation, Detroit, Mich., is made in five sizes, with a selection of three constant speeds per size, 1,750, 1,150 or 870 r.p.m. Multi-speed motors are also available on each size, to give quieter operating speeds with a high speed reserved for the warming up period.



Heater with duplex fan unit

The heaters are made entirely of copper and steel. All copper tubing that forms the heating element is fuse-welded to the ⅜-in. steel header. The sheet-steel casing is assembled and attached to the header by spot-welding.

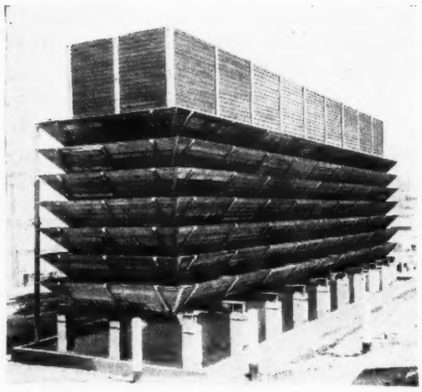
For hand operation, a self-contained totally inclosed manually operated switch with overload and under-voltage protection is furnished. For automatic operation a totally inclosed, externally operated across-the-line switch of the quick-break safety type, with thermal overload cut-out, is used in connection with a standard mercoid thermostat.

The heaters are adaptable for use with any electric current, floor recirculating boxes, or horizontal outside air intake boxes with recirculating dampers.

Spray Deck Cooling Tower

THE spray deck tower illustrated, in which is combined the advantages of the standard deck-type towers and spray ponds, has recently been added to the line of water-cooling equipment put out by the Marley Company, Kansas City, Mo.

In the new tower, troughs, launders and flumes are eliminated and a



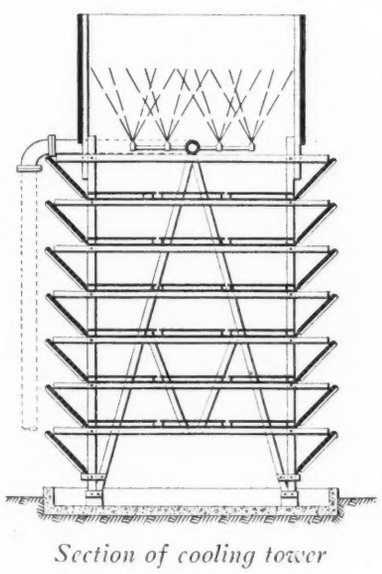
Spray deck tower of 1,000-g.p.m. capacity

spray pond is used in their place at the top of the unit. Large open-type spray nozzles, while eliminating any tendency to clog, give a fine break-up of the water. It is pointed out by the manufacturer that the incoming air as it is heated tends to rise through the spray pond, and due to the absence of decks in this section of the tower a large portion of the heat transfer is accomplished before the water reaches the decks below.

The spray system is supplied by a main distributing heater, to which all nozzles are attached. Large pipe sizes are used to give uniform pressure throughout the entire header and to reduce the friction loss to a minimum. Louvering is provided in convenient panels, each section being complete with retaining strips on each side, so that they may be fastened in place by a single bolt at each outside corner. The panel units are of a size and weight convenient for handling.

The decks are sectional, light in weight and arranged with part above and part below the supporting member. They are approximately four feet wide and are supported every thirty inches. The design of the decks provide for 50 per cent free area for the flow of air. The tower is braced horizontally and vertically, and the main tower footings are anchored by cast-iron base plates.

Some of the advantages claimed for this tower by the manufacturer are uniform water distribution, maximum break-up of water, increased air circulation, reduced height of tower and pumping head, and maximum heat transfer.

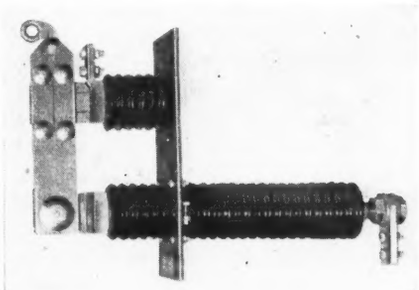


Section of cooling tower

Front- and Back-Connected Disconnecting Switch

THE new form of tongue-type front- and back-connected single-pole, hook-stick operated, disconnect switch illustrated, has been developed by the Delta-Star Electric Company, Chicago, Illinois.

The back-connected tube insulator is sufficiently long to pass through a thick wall and still give sufficient ground clearance.



Single-pole, tongue-type, disconnecting switch

The switch blade is provided with a positive safety lock operated by the standard hook stick. The back connected insulator tube is clamped to a steel base so that in case of accidental breakage the tube can be readily withdrawn and a new one inserted without dismounting the entire switch.

New Controller for Low-Head Cranes

A SELF-CONTAINED, triple-drum controller with a resistor mounted on the back, for the floor operation of the three motions of small, low-head cranes is announced by the General Electric Company, Schenectady, N. Y.

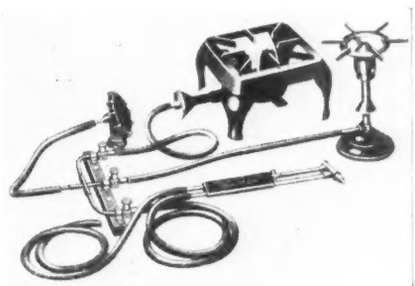
Self-contained controller for low-head cranes

The general construction is similar to that of the standard line put out by the company, with rope wheel having spring return, vertical or horizontal handle, all interchangeable. The horizontal handle arrangement is provided in case it is desired to install the controller in a crane cab for the usual method of manual operation. In such an installation the resistor can be separated from the drum switches which is necessary if all three motors are rated the full 10 hp. of the controllers.

Heat-Producing Equipment for Laboratory Research Work

WITH a view to providing a convenient source of intense heat for use in experimental and research work as carried out in the laboratories of the various central stations and industrial plants, the Prest-O-Lite Company, 205 East 42nd St., New York, N. Y., has introduced the equipment illustrated.

A complete laboratory installation consists of a small tank of dissolved acetylene; a hot plate; a Bunsen burner; an acetylene-and-air torch with air control; a reducing valve; a three-way branch valve and the



Heat-producing equipment uses dissolved acetylene and compressed air

necessary tubing. The flame can be easily controlled and is hot enough to melt various metals.

A special type of torch has been developed for test work. It uses compressed air in addition to dissolved acetylene. The flame may be changed from the brush type to an intense needle point by adjusting the air supply. The brush, or bunsen flame, has a temperature of approximately 2,800 deg. F. and the needle point flame produces approximately 3,300 deg. A wide latitude of temperature control is possible by adjustment of the gas pressure. Dissolved acetylene has certain advantages over liquid or other gas fuels. It not only produces a higher flame temperature than coal gas or natural gas, but forms a flame than can be perfectly controlled. This flame is said to be non-oxidizing and non-carbonizing as well.

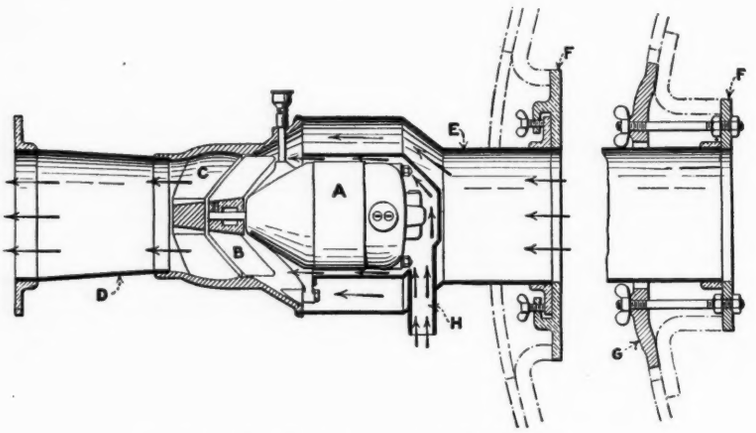
Boiler Manhole Exhauster

TO the line of blower and exhauster equipment put out by the Coppus Engineering Corporation, Worcester, Mass., has recently been added the manhole exhauster illustrated.

The exhauster is similar in practically every respect to the manhole blower made by this company except that it is designed to exhaust the air from the boiler drum or other vessels instead of blowing the air into them. It consists, essentially, of a motor *A*, fan *B*, guide vanes *C*, diffuser *D*, inlet thimble *E*, manhead plate *F*, yoke *G* and air-cooling pipe *H*. The motor is protected from dust in the air stream and is arranged for independent cooling by means of a separate housing, the air flow being as indicated by the arrows.

The flange on the diffuser *D* and the one on the inlet thimble *E* have the same dimensions, so that the unit can be reversed and used as a blower instead of an exhauster as occasion demands.

The exhauster is equipped with a ½-hp. built-in universal motor suitable for use with either direct or alternating-current, any number of cycles and 110 or 220 volts, also, a small circuit breaker having thermal overload protection and 12 ft. of cord with plug. It is built for hanhole sizes of 11x15 and 12x16 inches.

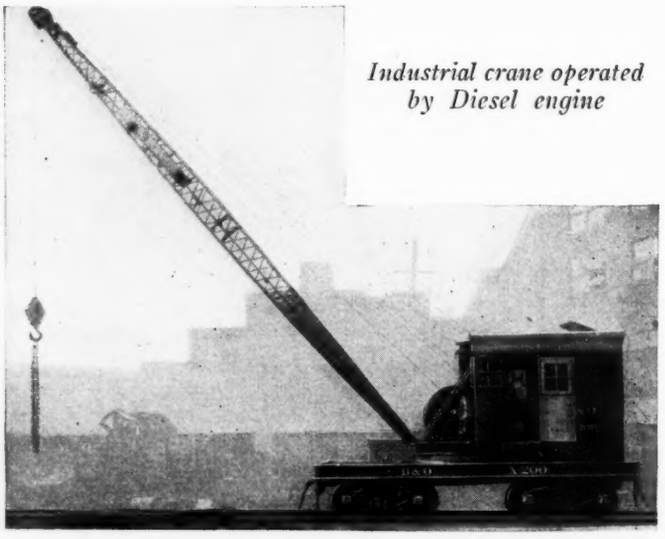


Section of exhauster mounted in manhole

Diesel Operated Industrial Crane

A DIESEL operated, 25-ton capacity locomotive crane has recently been announced by Industrial Brownhoist Corporation of Cleveland, Ohio.

The Diesel engine on the new unit is of the six cylinder, two-cycle, solid-injection type and burns any ordinary grade of fuel oil. The entire operating mechanism is mounted on a one-piece, cast-steel rotating bed and the side frames are also made of steel castings. The power take-off from the engine is fully enclosed, runs in oil and is equipped with anti-friction roller bearings.



Industrial crane operated by Diesel engine

Manganese-Chrome-Iron Welding Rod

A MANGANESE - chrome - iron welding rod called Hascrome is announced by the Haynes Stellite Company, of Kokomo, Ind. It is a self-hardening alloy, designed primarily for building up badly worn parts preparatory to surfacing them with Stellite, which is also supplied in the form of welding rod. Hascrome may be used for building up large sections of steel or cast iron, and forms a base for Stelliting, because it is sufficiently hard to resist deformation under impact and because of the ease with which Stellite flows onto it.

The oxy-acetylene process is considered best for the application of Hascrome, since the hardness of the deposited metal can be controlled by the amount of excess acetylene used in the welding flame, as well as by the rate of cooling. The greater the excess of acetylene in the flame and the slower the cooling rate, the harder the deposit will be. When quenched, the metal becomes softer and tougher. Hascrome is applied to steel without puddling the steel. Best results are obtained when the deposit is made just so the steel surface is at a "sweating" heat. It can also be applied by means of the metallic arc process.

SAFETY
in the Boiler Plant

STEAM boiler inspection was the pioneer of safety work in this country, having its inauguration about 1866, or 63 years ago. As a result of this inspection work many improvements in the design of boilers have been brought forth for the safety of the communities in which they are operated.

A summary of the record for 40 years (1880 to 1919) shows that during that period there were 14,281 explosions, in which 10,638 lives were lost and 17,085 persons injured; a yearly average of 266 persons killed and 427 injured, not to mention the loss of millions of dollars worth of property.

Causes of Accidents

The causes of boiler explosions are numerous, some of them being excess pressure, low water, water-hammer, electrolysis, unknown gases, scale, different forms of corrosion, structural weaknesses, and the human factor. Many engineers state that it is pressure alone that causes great damage. Were such the case it would not be permissible to test steam boilers by hydrostatic pressure equal to one and one-half times the approved steam pressure.

As an illustration of the "gun powder" contained in a steam boiler, we will take one of the most common, the horizontal return tubular boiler of 1,500 sq.ft., operated under normal conditions of 150 lb. gage pressure. In such equipment there are 284 cu.ft. of water and 102 cu.ft. of steam. Should this boiler explode, the energy released would be 190,876,968 ft.-lb. of water and 2,864,262 ft.-lb. of steam, a total of 193,741,230 ft.-lb., or approximately 268 tons lifted 100 ft. in the air.

High-Pressure Plants Require Special Precautions

In the high-pressure plant of today, care must be exercised to see that the men handling equipment become familiar with its peculiarities. A few years ago a peculiar accident occurred several times, four times in five months to be exact, and always at the same hour, 4 a.m. The water in the boiler lifted from its natural resting place and banged against the top of the drum with such force that it shook the entire setting, blowing the safety valve from the drum and shutting down the plant. Several 10,000-sq.ft. boilers were on the line, all equipped with automatic stop valves. These valves prevent steam escaping from boiler or line—that is, if a tube blew out of the boiler the flow of steam automatically closed the valve, and vice versa if the header blew out. After 1:30 a.m. the factory load would let up to such an extent that the load on the boiler was considerably lightened.

For the sake of economy, a couple of boilers were allowed to loaf, resulting, of course, in no flow, and the automatic would close and stop water circulation. Around 4 a.m. the boiler would be put in readiness for the 6 a.m. load, and at this time the accident would occur. When the automatic valve would close, the water circulation would stop, and no raw or fresh water being fed into the boiler there was no means of starting circulation; when the fire was again started and heat absorbed by the boiler the energy was all stored in the lower drums and the little molecules of steam could not form, resulting in no circulation until excess energy was stored, and then the entire body of water was lifted with terrific force to the top of the drum.

Monday Explosions

This is the very reason why so many boiler explosions occur on Monday morning. It took a great deal of investigation to get to the cause of this irregularity. The solution was finally found by experimenting with a glass bottle containing water. A clean glass bottle was used. It was partly filled with raw water and allowed to boil for a few minutes, after which the gas was shut off and a steam-tight cork fastened on the bottle and allowed to cool. Cooling in this way with the air-tight cork formed a vacuum in the bottle. After the water had cooled the gas was lighted and bottle again placed on plate. No sooner had the bottle been on the plate than the entire mass of water was lifted from the bottom of the bottle with terrific force, bursting the bottle into hundreds of pieces.

Further investigation disclosed a great many boilers are airtight after they are cut from service on week-ends and cannot be started up again on Monday morning without changing the water. From this it can be readily seen that a vacuum is formed in the top of the boiler. It is good practice to open the upper gage cock when starting up a cool boiler, although this is not always practiced. The same condition would exist in the illustration just given. In order to guard against such instances it is standard practice in many companies that no boiler after being run on the line and allowed to go out for any reason whatever is permitted to be lighted up again without first blowing out 20 per cent of the water in the boiler.

In another boiler, operating at 150 lb. pressure, a tube in the front row opened up to the fire side with such terrific force that it blew the entire furnace and surrounding equipment to pieces. In its path were two firemen, both of whom were scalded. One died after a few hours, and the other suffered the terrible agony produced by steam burns. The accident first described could have been avoided; the second was due to a failure in material, which is hard to discover.

The high-pressure plant of today requires special safety precautions because of the intricacies of its equipment. Every man in the plant should be thoroughly familiar with its peculiarities and have some idea of the possible causes of boiler accidents. In this abstract of a paper presented at the recent annual safety congress in Chicago of the National Safety Council, Garrett Burgess, consulting engineer, of Detroit, Mich., gives the benefit of his wide experience in boiler plant operation, laying particular emphasis on the causes and prevention of accidents

Training Necessary to Insure Safety

A change will eventually take place from the old boiler method to the modern steam generator. The first several units of this type generator in America are now being operated at a rating of 1,500 per cent. From the fact that if the source of water supply was shut off from this equipment it would require but 32 sec. to evaporate the water in the upper drum, as against the safety limit of three minutes with the boiler installation, it can be readily seen that the human element enters prominently in the operation of these generators. The matter of training men to handle this equipment was somewhat of a problem at the start, but this has been remedied by the men familiarizing themselves with the details of this installation before it is put in operation. The trend of engineering is undergoing so many changes that the licensing of engineers as it is now done does not protect the employer to the fullest extent, as such licensing covers mainly steam boilers to the exclusion of many other types of equipment now an integral part of power plant operation.

If progress is to be made in this great safety movement, the human factor must be considered. Men will have to be awakened to safety consciousness through training.

Diesel Engines Cannot Compete With Large Steam Units---

The author claims that Diesel plant costs are more than those of a modern steam plant of moderate capacity. For this reason the Diesel can be used economically only by public utilities in plants where at present the load does not justify the expense of a transmission line.

Says

F. W. MARTIN*
Sargent & Lundy

AT THE present time the chief source of electric power in the United States is steam-turbine plants. These steam plants vary in size from a few hundred kilowatts, in some isolated communities, to the mammoth super-power stations with a generating capacity of over 100,000 kilowatts. A brief comparison of steam plants and Diesel plants for central stations should be of interest.

As the largest Diesel engine built has a capacity of only 15,000 horsepower, there can be no competition between steam plants of over 50,000 kilowatt capacity and the Diesel-engine plants, just as there is no question of reciprocating steam engines in these huge plants. Any decision between Diesel and steam is therefore confined to the smaller plants, below 50,000 kilowatts in capacity. It would be folly to compare steam plants in localities where coal can be obtained for $2.50 a ton with Diesel engine plants, as, obviously, the fuel charge for the coal plant is so low that there is no question as to its being the more economical.

There are, however, certain sections of the country where oil abounds and coal is scarce. In Table I are the size and operating cost of six modern steam plants, of 5,000 to 30,000-kw. capacity. These plants are in the southwestern part of the United States and serve oil-field territory. A brief study of this table shows that the capacity-use factor of these steam stations is high, ranging from 32 per cent to 91.4 per cent throughout the year. The thermal efficiency is comparable with that of most of the Diesel plants, ranging from 14,819 B.t.u. per kilowatt-hour for the latest plant to 23,000 B.t.u. for the older and smaller plants. The total cost of operation of the steam plants varies from 2.04 mills per kilowatt-hour to 4.55 mills per kilowatt-hour.

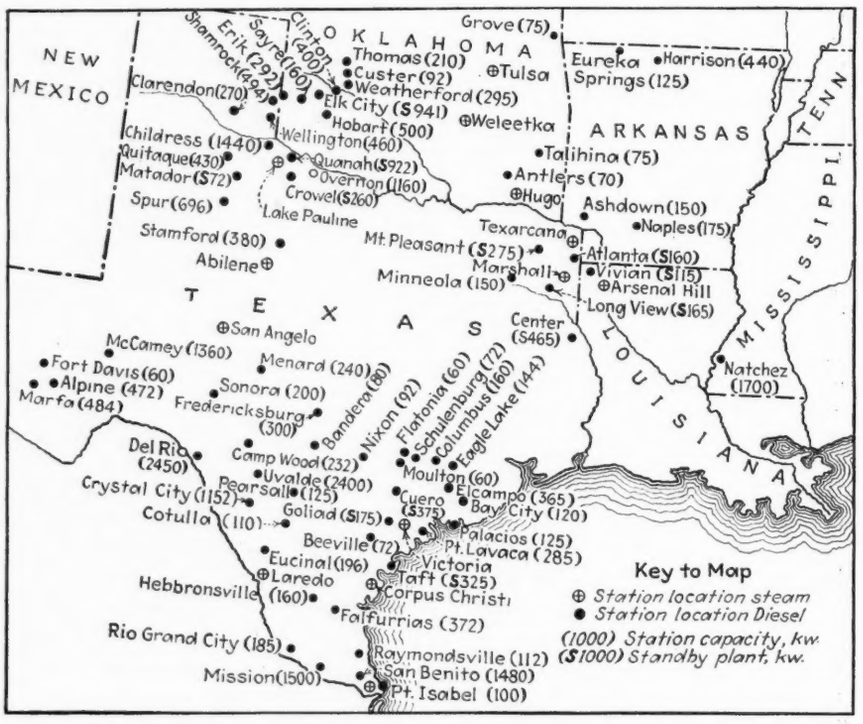
The N.E.L.A. data on Diesel engine operating costs, Table II, shows that the fuel cost alone for the best Diesel plant examined was 3.40 mills per kilowatt-hour, or 50 per cent more than the total operating cost of the best of these steam plants and nearly as much as the poorest steam plant. The total operating cost of the Diesel plants is, on the average, two to three times the total operating cost of the steam plants. The low fuel cost of the steam plants is due to the burning of the natural gas which exists in the oil fields.

It is also noticeable that the maintenance cost of the steam plants is much lower than that of the Diesel plants. The worst of the steam plants shows only 0.4 mills per kilowatt-hour maintenance, while the best of the Diesel plants shows 0.6 mills. The cost of miscellaneous items of supplies is only 0.2 mills per kilowatt-hour for the worst of the steam plants, against 0.54 mills for the best Diesel plant. If the average in each case is taken, the difference in favor of the steam plant is much larger.

Were these steam plants burning oil at the same price per million B.t.u. as the Diesel plants, the picture would be but little changed. Power from the most economical Diesel plant would still be about 50 per cent higher than power from the 15,000-kw. and 30,000-kw. steam plants and somewhat more expensive than power from the 10,000-kw. steam plant. The cheapest Diesel power, however, would be slightly cheaper than power from the 5,000-kw. plants. The average cost of power from the Diesel plants would still be much higher than the average cost of power from the steam plants.

Diesel Plants in the Oil Fields

The map of the middle and southwestern portions of the United States shows the location of the Diesel plants owned by a large public utility company in Texas and Oklahoma, as well as the principal steam plants belonging to the



Central Stations Owned by an Operating Utility in the Southwest

*Abstract of paper read before the Western Society of Engineers.

TABLE I—STEAM PLANT OPERATING COSTS

	Plant No. 1	2	3	4	5	6
Capacity, kilowatt	15,000	15,000	30,000	10,000	5,000	5,000
Generated, kilowatt-hour	120,220,000	23,829,000	83,556,000	61,509,900	38,836,400	22,567,000
Capacity-use factor, per cent	91.4	.....	31.7	70.2	88.7	51.4
B.t.u. per kilowatt-hour	15,363	14.819	18,622	18,400	22,256	23,010
Labor, mills	0.402	0.354	0.538	0.433	0.629	0.545
Fuel, mills	1.492	1.445	1.740	3.058	3.365	3.283
Miscellaneous, mills	.059	.200	.117	.169	.160	.231
Repairs, mills	.086	.063	.173	.394	.393	.414
Total operating cost per kilowatt-hour, mills	2.039	2.062	2.568	4.054	4.547	4.473

same company in that territory. This territory is in the midst of extensive oil fields. The price of fuel oil is therefore as low as anywhere in the country. Coal, on the other hand, is scarce and of low grade. The population is small and widely scattered. New or boom towns spring up over night as new oil wells come into production. The water supply in many localities is meager and hard to get. All these factors indicate a territory where the conditions are as favorable to the Diesel engine as can be found anywhere.

The map shows a large number of Diesel central stations. In the boom oil towns and small isolated villages Diesel engine plants are installed to furnish electricity to the local customers. As the population increases and the electricity demands become stabilized, steam plants are erected at favorable locations and high-tension transmission lines built to the outlying communities. The steam plant then becomes the principal source of electricity and the Diesel plant is relegated to stand-by or emergency service, in case of damage to the transmission line, because of the much lower cost of electricity from the steam plant.

The Diesel plant is well-suited to local stand-by service, as its stand-by charges are not heavy and it can be quickly started and loaded to full capacity. The Diesel engine is limited to local service, however, because the machines are of too small capacity to energize a long transmission line. The figures given in the tables attached to this paper apply to central stations such as are built in the oil-field territories. Practically no steam central station would be built at the present time under about 5,000-kw. capacity, and even this is very small. There is a definite size of power plant below which a Diesel plant is somewhat more economical than a steam plant of the same size, providing there is no commercial use for the exhaust steam. Just what this size is depends upon local conditions of fuel supply, water supply, labor, load factor, etc.

It may be pointed out that the figures given in this paper do not include transmission-line costs. However, a considerable length of transmission line can be maintained before the station generating cost is doubled. In addition, the modern steam central station, such as is considered here, costs less per kilowatt of capacity to build than the Diesel plants it replaces.

While many of the Diesel plants are being superseded for base-load operation by steam plants, there are still many isolated communities too far removed from a steam plant to warrant the construction of a transmission line and where there is not sufficient water to permit the construction of a steam plant. These communities for some time to come will be served by Diesel-electric plants, in spite of the higher production cost.

In conclusion, it can be stated that the Diesel engine has increased by rapid strides in the marine field, and in world tonnage under construction has passed the steam engine as a means of propulsion.

In the central station field the Diesel engine has a very definite place. It serves as a temporary source of power in isolated and rapidly growing communities until a transmission line can be built from the nearest steam station to supply the load. It requires much less water than a steam plant and consequently can furnish a source of power supply in communities where water is scarce. It makes good stand-by capacity in small communities at the end of long transmission lines to furnish power for the local load in case of line trouble.

The Diesel engine cannot compete as a source of electric power with a modern steam central station of 10,000-kw. capacity or larger.

If low-cost boiler fuel is available, such as coal or natural gas, the Diesel engine cannot compete as a source of electric power with steam central stations of even 5,000-kw. capacity. However, there is a size of power plant, depending upon local conditions, below which the Diesel engine is more economical than a steam plant of the same capacity.

TABLE II—DIESEL ENGINE OPERATING COSTS

	Plant No. 1	2	3	4	5	6	Av. of 32 Plants
Capacity, kilowatt	2,450	2,400	1,400	960	1,160	1,700	26,657
Kilowatt-hour generated	9,601,479	6,948,460	4,414,800	4,765,300	2,857,094	4,238,000	57,216,642
Capacity-use factor, per cent	44.6	33.0	35.9	56.5	28.0	28.4	24.4
Fuel, lb. per kilowatt-hour, per cent	0.79	0.68	0.74	0.90	0.70	0.69	0.84
B.t.u. per kilowatt-hour	15,020	12,920	14,452	17,100	13,670	13,110	15,960
Labor, mills	1.34	1.56	1.69	1.54	2.72	2.71	2.44
Fuel, mills	4.20	3.40	3.70	4.80	3.50	3.30	4.50
Water, mills	0.02	0.03	0.38	0.37	0.10	0.15	0.17
Lubricants, mills	.25	.37	1.02	1.39	0.68	0.78	0.99
Other supplies, mills	0.27	0.30	0.60	0.40	1.13	0.35	0.50
Engine maintenance, mills	0.43	0.65	2.84	0.85	0.86	0.45	1.33
Other maintenance, mills	0.18	0.17	0.62	0.21	0.06	0.27	0.43
Total production cost, mills per kilowatt-hour	6.69	6.48	10.85	9.56	9.05	8.01	10.36

Power Production Growing in Great Britain Report Shows

A SUBSTANTIAL advance in the use of electricity in Great Britain is disclosed by the report of the Electricity Commission relating to the generation of electricity in that country during the fiscal year ended March last. The total output of the 564 stations enumerated in the survey was 10,878,980,925 kw.-hr., an increase of 9.58 per cent on the figures for the previous year.

Since the 9,562,109 tons of coal, coke, and oil consumed in producing this output is only 3.66 per cent higher than the last figure, greater efficiency was attained. It is of interest to note, however, that the kilowatt-hours generated by water power materially increased. In 1928-29 a total of 149,518,929 kw.-hr. was produced, as against 104,228,257 in 1927-28, a rise of 43 per cent.

The use of water power on a large scale is almost exclusively confined to the West of Scotland, and the North Wales neighborhoods. Even last year only 1.37 per cent of the total output of electricity emanated from this source, as against 95.39 per cent produced by steam.

Next to steam the largest source of power was waste heat (2.20 per cent), which was responsible for as much as 223,719,459 kw.-hr. in the Northumberland and Durham area. Refuse destructors provided fuel for the generation of 20,629,444 kw.-hr. of current, a slight drop from the previous year's total.

Tables of fuel consumption furnished by the commissioners show that the average consumption per unit increases as the scale of production diminishes. The super-power stations—those producing 200,000,000 kw.-hr. and over—give an average of 1.73 lb. of fuel per kw.-hr. The next group, consisting of stations of 100,000,000-200,000,000 kw.-hr. output, have an average of 1.92 lb. So the figures mount as the smaller station groups are reached until the steam producers of from 1,000,000 to 5,000,000 kw.-hr. show an average of 7.02 lb.

The lowest fuel consumption of any steam station was that of the Padiham station of the Lancashire Electric Power Company, a station of the 50 to 100 million class. This, with 1.33 lb. per kw.-hr., actually beat the best of the super-power stations, North Tees, with 1.35 lb. per kilowatt-hour.

In the matter of thermal efficiency, the highest percentages in their respective groups were made by Padiham, 21.35 (steam); Lewes and District, 28.29 (oil engine); and Blandford and Forum 16.72 (gas).

The station producing the greatest output in the country last year was Barking County, of the London Electric Supply Company, with 400,494,400 kw.-hr. The Barton station of the Manchester Corporation produced 359,671,350 kw.-hr.; Lots-Road, London Electric Railway, 337,631,262, and Prince's, Birmingham Corporation, 309,243,500 kw.-hr.

FROM AMONG READERS' PROBLEMS

Conducted by
L. H. MORRISON

LUBRICATING OIL DILUTION—*In our vertical four-stroke-cycle mechanical-injection Diesel we are using a lubricating oil recommended by the engine builder. The oil seems to get dirty quickly. A chemist reports that a sample shows dilution from the fuel oil. This engine operates on a light load for about half the time. Could that be the cause?* A.F.J.

The engine you mention has a single fuel pump for all the cylinders. When operating on low loads, the amount of oil reaching each cylinder may be so small that it fails to fire, as the cylinder is cold. This oil will drip down into the crankcase. You can do little to avoid the trouble, but the oil can be cleaned by clarification. If the engine had individual fuel pumps, the oil to one or more cylinders could be discontinued, thereby forcing the other cylinders to carry all the load and thus keep warm enough to ignite the fuel.

TURBINE BEARING RUNS HOT—*We have a 2,500-kw. turbine which runs hot at the bearing on the exhaust end. What is the cause?* F. C. J.

One of several things may cause the overheating. The lubricating oil may have formed a sludge that stops up the oil lines. The babbitt lining of the bearing may be in bad shape. It is possible that the turbine was aligned when cold and the displacement occurring when the casing became heated may have thrown the heavy housing against the shaft. You might uncouple the shafting while the turbine is still warm and check the alignment at the coupling.

EFFECT OF HUMIDITY ON A GAS ENGINE—*Some time ago the statement was made in* Power *that tests revealed that increased humidity of air reduces an engine's efficiency and power. If this be true, why does the introduction of water in blast-furnace gas increase an engine's power?* D. J. D.

The reason the cooling of the blast-furnace gas does increase the engine's power is that it increases the weight of gas per cubic foot and so permits a large weight charge to enter the cylinder. This, of course, increases the power output.

PIPE LINE VELOCITIES—*In a CO_2 refrigerating system what should be the velocity in the pipe lines?* P.J.D.

For the suction lines 1,000 to 1,500 ft. per minute are fair values; liquid velocities should be kept down to about 500 ft. per minute.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

THE formula for calculating the sensible heat contained in the dry flue gas per unit of fuel burned is: Weight of gas × specific heat × (T — t) = B.t.u. If T is the temperature of the gas on leaving the boiler, what temperature should t equal —that of the boiler room or of the air outside, and why?

THE best authority for settling such a question is the "Test Code for Stationary Steam Boilers," published by the A.S.M.E. The code states that the sensible heat contained in the dry flue gases should be calculated from above the temperature of the air surrounding the boiler. It is assumed in the code that the air used in combustion is air coming from the boiler room. Exceptions exist where forced-draft fans draw a special air supply.

There are several reasons in the usual test for using boiler room temperature in preference to that of the air outside. The furnace, by the combustion process, heats the air from room temperature to furnace temperature, and the boiler then removes heat from the furnace gases down to boiler uptake temperature. Outside air temperatures are in no way involved. In calculating a heat balance, the purpose is to balance the heat delivered to the furnace, which is in the form of coal, plus heat in the feed water plus heat in the air for combustion, against the heat lost into the steam, flue gases, and radiation. If that principle is kept in mind, it is obvious that the sensible heat in the flue gases should be calculated from their initial temperature as air entering the furnace. The furnace must not be charged with receiving heat that is added to the air not in the furnace but in the boiler room, and that is what would be done if outside air temperature was used.

It might be argued that the boiler room air is warmer than outside air because of heat lost from the boiler, and that therefore the boiler should be credited with this heat. This is partly true, but boiler room air is also heated by radiation from steam lines and many other items of equipment. It is not desirable to regard a poorly insulated boiler and furnace as an air heater, and a heat balance should charge radiated heat as lost even though some of it is returned to the boiler.

Special cases might make an exception. The fundamental principle is to base the heat balance on temperature of air to the furnace. If forced-draft fans were drawing air from the engine room basement or possibly from outside the plant, it would be correct to use temperatures taken at the source of air supply. In the code, air heaters do not affect the situation, for the sensible heat is measured from temperature of air into the heater to temperature of flue gas out of the heater.

G. V. WILLIAMSON
Ass't Chief Engr.
Union Electric Light & Power Co.
St. Louis, Mo.

THE rise in temperature of the air inside the boiler room from that of the outside air is due to the loss of heat by radiation from the boiler and setting, and must be charged to the efficiency of the boiler and setting and not the chimney; therefor, t equals the temperature inside the boiler room.

HARRY SYLVESTER.
Detroit, Mich.

HEAT enters a boiler setting as: Heat available only through combustion and as sensible heat represented by weights of fuel and combination air at temperatures existing at the entrance to the boiler setting.

Of the various useless amounts of heat escaping from boiler settings, the largest is "dry gas loss." It is sensible heat, and is a loss to the extent that the temperature of exit gases exceeds the temperatures of air and fuel originally furnished to the setting.

Temperatures of air, admitted to the setting voluntarily, should be measured at the point of entrance. Air leaking in, as shown by CO_2 drop between the first pass and the boiler outlet, should be taken at the temperature existing around the boiler at the points where the principal leakages are thought to occur.

Hollow air-cooled settings which ultimately discharge their air into the furnace should be considered part of the furnace design, and air temperatures should be measured at the entrance to the walls.

Added efficiency, caused by *separate* air preheaters, can be approximately represented by taking for t in dry gas loss the preheated air temperature. To avoid the slight error caused by the drop in CO_2 due to leakage, first figure a heat balance with t = room temperature of air, then add the sensible heat returned as preheat, using this formula: Pounds air admitted to furnace $\times$ .24 $\times$ $(T_1 - t_1)$ = Sensible preheat, where T_1 is the preheated air temperature and t_1 the room temperature.

By recalling that, theoretically, 7.6 pounds of air is required for 10,000 B.t.u. of fuel, and that furnace CO_2 immediately establishes the percentage of excess air, the application of this formula becomes easy.

JOHN F. KYES, JR.
Riley Stoker Corp.
Worcester, Mass.

IT IS customary to use the temperature of the boiler room as the value of t. The term $(T - t)$ expresses the temperature range, and appears in other formulas in computing the heat balance losses due to: Moisture in coal, moisture formed in burning hydrogen, and moisture in air.

Should the temperature of the outside air be taken as t it will increase the percentages in the heat balance of the items using $(T - t)$. The per cent loss in the dry chimney gases will increase the most, and the "radiation and unaccounted losses" are reduced that increase.

It can be argued that it is logical to use the outside temperature, as the radiation losses of the boiler tend to heat the boiler room.

The quantity 0.24 is taken as the mean specific heat of the gases between the temperature limits, and this specific heat will vary with the temperature and composition of the escaping gases. The value W must be computed from the analysis of the flue gas. At best, the formula under discussion has several quantities that may vary. The question is: Should one item in the formula be carried to such a refinement when other items are not definitely established and fixed? G. A. GLICK.
Sheboygan, Wis.

THIS formula is used in figuring a boiler and furnace heat balance to ascertain the quantity of heat per unit of fuel that is carried away by the flue gas. Any heat that the air for combustion contains before it enters the furnace is not received during the process of combustion and should not be credited to the furnace. Therefore, the temperature of the air entering is subtracted from the flue gas temperature.

DANIEL HEGARTY
South Groveland, Mass.

IN CALCULATING the sensible heat contained in the dry flue gases per unit of fuel burned t should be the temperature of the boiler room and not the temperature of the air outside.

The temperature of the air in the boiler room is invariably higher than that of the air outside, due to heat absorbed by radiation from boilers, steam pipes and other sources.

The excess heat of the air in the boiler room over that of the air outside has not been added at the expense of any portion of the heat contained in the fuel as fired, except indirectly, and it cannot properly be accounted for in the heat balance, which in that case would account for more heat per pound of fuel than is actually contained in a pound of fuel as fired.

The problem is similar to that involved in determining the amount of heat absorbed by a boiler per pound of water evaporated, which equals the total heat of one pound of steam at boiler pressure less the heat contained in a pound of feed water entering the boiler.

The boiler is not credited with all of the heat contained in a pound of steam, because it did not raise the temperature of the feed water from 32 deg. F. to the temperature of the feed water entering the boiler.

Similarly, the furnace cannot be credited with having raised the temperature of the outside air to that of the boiler room. Therefore the latter temperature must be used in calculating the stack loss. PETER G. DAHL.
Chicago, Ill.

A Question for Our Readers

ARE water-wall furnaces justified in an industrial power plant when the plant runs but 10 hr. daily and the hourly output varies from 25,000 to 60,000 lb. of steam?

C.V.R.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Jan. 21, 1930, issue.

THERE should be little argument as to which temperature should be used. Accepted practice has always used adjacent, or room, temperatures when calculating losses from radiating surfaces.

The air used under fires, in practically every plant, is taken from the boiler room, and calculation of losses suffered by heating this air is based on boiler room, not outside temperature. So it would seem more nearly correct to substitute boiler room air temperature for t in the formula given.

RALPH J. DALTON,
Mechanical Rubber Co.
Cleveland, Ohio

IN THE formula weight of H is the sensible heat loss in B.t.u. per pound of fuel burned, W is dry flue gas per pound of fuel, c is specific heat of dry flue gas, equal to 0.25; T and t are gas and air temperatures, respectively, the point of measurement of which depends on the installation.

Since it is indicated that T is the temperature of the gas leaving the boiler, it is presumed that there are no heat-saving devices on the unit. An analysis of the formula will indicate that t should equal the temperature of the air entering the furnace, regardless of the source of supply. The equation gives a heat loss that is supplied by the fuel. Therefore, the measuring point for the air temperature must be that at which the fuel and air come in contact. Then t should equal the temperature of the air entering the furnace.

If the boiler unit contains an economizer, T must equal the temperature of the gas leaving the economizer; or for a heat balance "without economizer," T is the temperature of the gas leaving the boiler. For either condition t is the same as before.

If the installation includes an air preheater, T must equal the temperature of gas leaving the preheater, t being as before. Without preheater, use T equal to the temperature of the gas entering the preheater, and t equal to the air temperature entering the preheater.

A. W. THORSON
Detroit, Mich.

THE question assumes the air intake to be in the boiler room. The sensible heat in dry flue gases is one item of a heat balance. Were the radiation losses known or were the boiler room air receiving heat from sources other than the boiler tested, then room temperature must be used for t. If the radiation losses are not obtainable, then the outdoor temperature may be used. This calculation would include sensible heat in flue gases plus radiation losses, provided the boiler room air were receiving heat from no other source.

It is a fact that boiler room air is warmer than outdoor air, because it absorbs most of the radiation losses.

Since in accurate tests the radiation losses are obtained, t is always taken as room temperature. When the radiation losses are unknown and one desires to decrease the "unaccounted-for loss item," then the outdoor temperature can be considered in the calculation as a means of approximately determining the radiation losses. Or room temperature minus outdoor temperature times the rest of the equation used in the question equals heat losses, which are equal to most of the radiation losses, provided the air receives no heat from any other source. JULIUS BERGER.
Newark, N. J.

A number of readers have expressed the belief that t should be the outside temperature. In this they were undoubtedly in error.—L. H. M.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot * News

CONSTRUCTION *of the first unit of a* $9,000,000 *hydro-electric plant on the Roanoke River near the Virginia-North Carolina line will be started in* 1930, *it has been announced by the Virginia Electric & Power Company, of Richmond. Preliminary engineering work is now under way on the huge project.*

* * *

PRODUCTION *of bituminous coal for the week ending Dec. 7 was the highest of any week since February, while that of anthracite was the highest for any week since that ending Oct.* 19. *The soft coal output was* 11,679,000 *net tons, and the anthracite output was* 1,923,000 *net tons.*

* * *

DECLARING *that adoption of the metric weights and measures by the United States will be urged energetically during this session of Congress, Representative Fred A. Britten of Illinois has introduced two resolutions in the House. One provides for a survey by the Secretary of Commerce, and the other recommends the adoption of the metric system.*

* * *

NOVEMBER SALES *of mechanical stokers, as reported to the Department of Commerce by ten leading manufacturers in the industry, totaled* 107 *of* 39,469 *hp., as compared with* 178 *of* 56,108 *hp. in October and* 116 *of* 30,938 *hp. in November,* 1928.

* * *

EMERGENCY GENERATORS *at the Moline, Ill., plant of the United Light & Power Company were called into service the night of Dec. 5 when a short circuit in the Riverside plant at Bettendorf, Iowa, disabled that unit with a loss of $4,000. The two plants were providing 23,000 kw. at the time, and until the Moline generators were ready for service, the community was without power or light.*

* * *

PRODUCTION *of crude petroleum in the United States during October amounted to 88,104,000 bbl., according to reports received by the Bureau of Mines. Although this represents an increase over the previous month in total output, the average daily production declined by 67,000 barrels.*

Coal Carbonization for Power Stations Discussed at British Conference

AT a joint conference recently held in London, England, by the Institution of Electrical Engineers and the Institute of Fuel, three lectures were delivered dealing with American, British, and German practice in the low-temperature carbonization of fuel, with special reference to its combination with the production of electrical energy at power stations.

S. McEwen, the American lecturer, pointed out that it was not so easy to achieve economic success in the pre-treatment of coal, because a process that is both technically and commercially successful with domestic fuel as one of the products might not be commercially successful if the solid fuel were utilized for power production. Fuel for domestic purposes can be sold at a high price, usually for considerably more per unit of weight than that of the coal from which it is produced, but this is not true of power plant fuel. The power station engineer of today is concerned with heat units only. He is not so much concerned with the physical condition in which the fuel is supplied to him.

Small Margin of Profit

The pre-treatment of coal with recovery of byproducts, which is to be followed by the combustion of the solid residue, is not favored by any appreciation in the value of the solid residue. Hence a low-temperature process operated in conjunction with a plant for electric power generation has a much smaller margin of profit than low-temperature processes that yield, as one of the main products, a high-grade domestic fuel. To secure an equivalent profit, the pre-treatment plant for use in conjunction with a power plant must be cheaper to operate, have a lower capital cost, and secure the maximum possible revenue from all the byproducts. These conditions involve the production of gas that can be sold for town supply, because conditions in America indicate that should the gas be burned under the boilers and the heat in that gas be credited to the carbonization plant at a rate per B.t.u. slightly above that of the original coal, the pre-treatment process would be handicapped to the point of economic failure. This conclusion points to the necessity for a working alliance between the electric power producer and the gas distributor.

In the British contribution to the conference, E. H. Smythe and E. G. Weeks described the Babcock process of low-temperature coal distillation employed at the Dunston station of the Newcastle-on-Tyne Electric Supply Company, which they believe is the only process developed and operated in Britain with the primary object of combining low-temperature carbonization of fuel with the production of electric energy. The plant was designed for the production of an ideal power station fuel, low in volatiles, and therefore smokeless, and for the recovery of the more valuable byproducts consistent with the production of such a fuel. The broad result is that sixteen gallons of tar oils and $\frac{3}{4}$ ton of semi-coke are produced from one ton of Northumberland small coal costing $2.75, the byproducts available for sale after the smokeless fuel and gas have been used for steam-raising purposes having a value of $2.22.

New Field for Power Plants

The authors claim that a new situation has come into existence, in which a practical process of coal distillation has been evolved in conjunction with the generation of electricity. The power station of the future, they suggest, will take coal in as its raw material, but will deliver, in addition to energy, motor fuel, fuel oil, creosote, pitch, and other derivatives of coal tar.

Professor P. Rosin, dealing with German practice, said that low-temperature carbonization was originally intended as a means of producing oil, low-temperature tar being the main product, while the semi-coke and gas were regarded as byproducts. This view has undergone a complete change on account of the many disappointments and economic failures of low-temperature processes using German coal.

Little Tar in Pit Coal

German pit coal does not contain enough tar to cover the cost of carbonization. The profit must be derived from the sale of semi-coke, at much higher prices than those obtained for raw coal. The value of the tar obtained from the low-temperature carbonization of pit coal, for which the price under the most favorable conditions would not be higher than that of fuel oil or Diesel oil, is generally insufficient to cover the capital charges and working expenses of the carbonization plant, and consequently the economic utilization of the gaseous products of distillation, which were formerly almost entirely neglected, is now attracting much attention. As it has a high calorific value, this gas should be

a welcome contribution to the public supply, but up to now its utilization has not assumed any practical significance in Germany. However, Professor Rosin considers that in the near future the gas will be looked upon as being of greater importance than the oil.

The position as regards German brown coal is quite different from that of pit coal. The tar, and not the coke, is the main product, as the value of the tar produced is more than 2½ times that of the coke. The large brown-coal power stations make use of a certain proportion of coal in which the percentage of tar is such that its carbonization is well worth considering.

Surplus of Semi-Coke

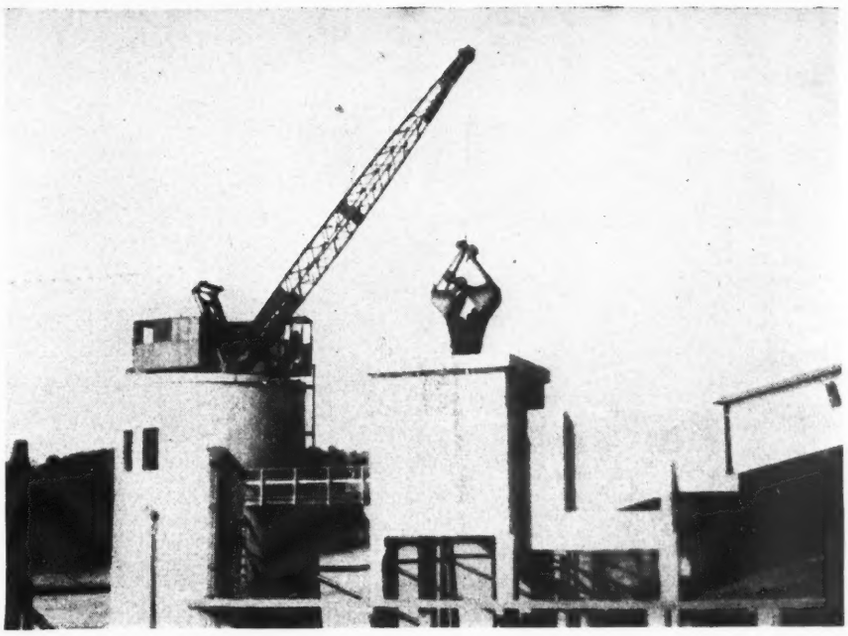
On the other hand, there are the independent carbonization works that already have a surplus of semi-coke and find difficulty in disposing of it. In many cases, these works dry the coal with back-pressure steam before carbonizing, this back-pressure steam having by previous expansion produced more electrical energy than is required by the carbonizing works for its own purposes. For this reason the idea has been conceived of establishing lignite carbonization power stations in which the coal will be wholly or partly carbonized prior to combustion, and better use made of its valuable tar contents.

This idea first assumed tangible form in Germany and was developed there for the first time on a large scale. The pioneer of this method was the Hessen-Frankfurt A.-G. (Hefrag) with its brown-coal carbonization stations at Wolfersheim, and this undertaking has shown the way to a remunerative combination of electricity production with the low-temperature distillation of brown coal.

Addition to Marysville Plant Announced

Capacity of the Marysville steam plant of the Detroit Edison Company will soon be increased to 160,000 kw. by the addition of a 50,000-kw. turbine-generator, according to a recent announcement of P. W. Thompson, chief assistant engineer of power plants. With the exception of changes in the casing and valving due to the 290-lb. pressure at Marysville, the rotor of the new turbine will be identical with the rotors now in service at Trenton Channel and Delray No. 3 plants. There will be only two stages of bleeder heating of boiler feed water with a 52,000-sq.ft. surface condenser and the usual pumps.

In 1930, a new boiler will be installed at Marysville, and during 1931 an addition to the boiler room structure is to be built to accommodate two more boilers, which will make ten boilers in all for a load of 160,000 kw. The original design called for a total of twelve boilers for a 140,000-kw. load, said Mr. Thompson, but the installation of economizers has made this unnecessary.



IN THIS unusual coal-handling installation at the plant of the Gulf States Service Company in Holt, Ala., the special Link-Belt crane is mounted on top of a concrete structure inclosing a water-intake screen. It has a special housing with levers moved forward, and unloads from 400-ton river barges to the receiving hopper in the center

"Lexington" Ties in With Tacoma's Power Supply

Permission has finally been granted by the Navy Department to use the naval airplane carrier "Lexington" to supplement the power supply of Tacoma and Seattle, Wash., which have been suffering a serious lack of electricity due to the unusually low water in their hydro-electric plants. Coincident with this announcement comes the report that rains have set in, which will soon relieve the situation. The drought in this section of the country has been the worst in 39 years.

The "Lexington" is now tied up to a dock in Tacoma harbor. A special transmission line has been run from the nearest sub-station in the city, where special transformers have been installed. The city will use 20,000 kw. for approximately 30 days, it is estimated.

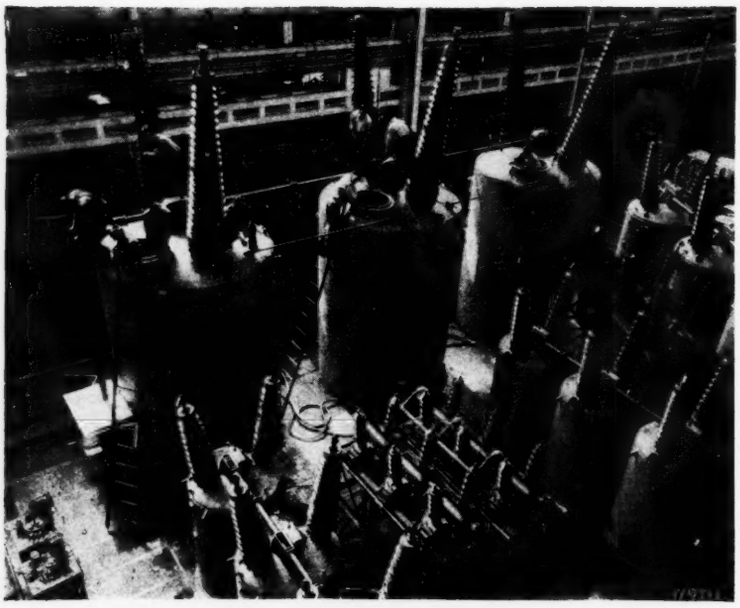
The power plant installation in the airplane carrier consists of four main turbine-generators with a total capacity of 140,800 kw. Each turbine is rated at 35,200 kw. and operates at a steam pressure of 265 lb. with 50 deg. superheat. The generators are rated at 40,000 k.v.a. each, with a power factor of 88 per cent and a voltage of 5,000. The frequency of the current is 58.5. Although special arrangements were necessary, no great difficulty was experienced in tying in this plant with the city's supply.

Navy officials did not look with favor upon this usage of the "Lexington," and withheld permission to use it until the very last minute. They took the position that an extreme emergency must exist before they could furnish any relief. That such an emergency existed long before the Navy Department lent its aid is evidenced by the fact that the outputs of hydro-electric plants in this area were reduced to one-third, and in some cases to one-fifth, of their normal ratings by the severe drought.

Portland Electric Plans 1930 Extensions

The Portland Electric Power Company, in 1930, will spend $4,300,000 on new construction in the light and power department, according to Franklin T. Griffith, president. The largest item is for increase and betterment of generating facilities, $2,601,750, which covers the installation of a new 35,000-kw. steam turbine at Station L, and an additional waterwheel and generator of 25,500 kw. capacity at the Oak Grove hydro-electric plant. The foundations for the new hydro unit were completed in 1929, and during 1930 the power house will be enlarged and the additional turbine and generator will be installed. This is the second step in the development of this site, which originally contemplated three successive steps.

In addition to the 35,000-kw. turbine-generator at Station L, a new 25,500-sq.ft. Stirling boiler and 45,000-sq.ft. Ingersoll-Rand condenser will be installed, with feed-water heaters, evaporator and other auxiliaries. The turbine will operate at a pressure of 385 lb. It is expected the new additions will be completed by Oct. 15, 1930.



WORLD'S largest oil-circuit breaker on test at the East Pittsburgh plant of the Westinghouse Electric & Manufacturing Company. Rated at 3,000,000 arc kva. on a 220-kv. line, this huge breaker will be installed in the Roseland substation of the Public Service Company of New Jersey. Note the comparative size with the 110-kv. breakers at the right

Work Started on Power Plant for Natural History Museum

Ground has been broken for a new four-story power plant building to serve the American Museum of Natural History in New York City. Four Babcock & Wilcox 4,650-sq.ft. boilers will be installed, with provision for two more boilers of the same size when load increases make them necessary. The boilers will operate at a pressure of 150 lb., furnishing steam to one 750-kw., one 500-kw. and two 200-kw. corliss engines and one 100-kw. uniflow engine for night service. Furnaces will be equipped with chain-grate stokers and forced draft. Complete automatic coal- and ash-handling equipment will be installed.

Large foundations will be laid for the 200-kw. engines, so that they may later be replaced if necessary by larger engines. Other equipment to be installed includes two 25-ton motor-driven ammonia refrigerating machines and air compressors.

The plant and building will cost approximately $1,250,000. Harry J. Langham, well-known member of Stevenson Association No. 44 of the National Association of Power Engineers, is chief engineer of the museum plant and responsible for the design of the new plant.

Steam Best for Australia Survey Shows

Among the conclusions reached in a recently completed report on the power situation in Australia, made under the auspices of the Australian government, is the finding that except in a few favored locations, hydro-electric generation is either impracticable or impossible and that the chief reliance must be placed in better utilization of the lignites and low-grade fuels that occur near the consuming centers. This report has been received by the electrical division of the Department of Commerce from its foreign agents.

The report also emphasizes the importance of standardizing frequency and pressure throughout the country. In regard to interconnection, it is stated that save in Tasmania and Victoria, the character of the territories served make a general hooking up undesirable from an economic standpoint. It is pointed out that even though inter-connection may be impracticable in most cases, the power systems in a number of instances can be substantially strengthened by tying in with manufacturing plants that can produce byproduct power.

Another conclusion stressed in the report is that private capital would be more inclined to invest itself in power development if more complete information on the natural resources were available. Recommendations have been made therefore that investigations should be made of areas considered favorable for economic development and that the fullest information of the findings be published so as to attract private capital.

New South Wales has the greatest capacity for water-power development, it is stated. The total amount of power that can be developed by this means is estimated at 250,000 horsepower.

In regard to increase and co-ordinating the power facilities of Sydney, the report refers to some views expressed by an officer of the City Council Electricity Department advocating the use of inferior coal for generating current in a modern steam plant 30 or 70 miles south of the city. This city official believes that a large plant at such a location would be a desirable improvement over the present four plants. The proposed plant would be near the ocean, so that an inexhaustible supply of cooling water would be available and it would also be close to a thick seam of inferior coal carrying up to 30 per cent of incombustible matter. This coal would be worth more than higher grade fuel, it is pointed out, because the cost of transportation would be negligible.

Alabama Power Companies Consolidate

Consolidation of a group of south Alabama power companies was authorized recently by the Alabama Public Service Commission. The permit provides organization of the General Water Works & Electric Company, to absorb holdings of the River Falls Power Company, the Pea River Power Company, Andalusia Light & Power Company, Opp Light & Power Company, and the Alabama Utilities Company.

Calif. Power Demands Met Despite Drought

Although the State of California is confronted with a serious water shortage, the four principal power companies, the Pacific Gas & Electric Company, Great Western Power Company, The San Joaquin Light & Power Corporation, and the Southern California Edison Company, are facing the situation with confidence.

The lack of rain and of snowfall in the mountains have greatly reduced the output of the hydro plants on the Pacific Gas & Electric Company's system, but as the water has dropped off it has been replaced with steam, and at the beginning of December about half of the entire load was being carried by the company's steam stations, of which there are four, two in San Francisco, one in Oakland, and one in Sacramento.

The ability of the Great Western Power Company and the San Joaquin Light & Power Corporation, which serve northern and central California, to meet power demands upon their systems, is outlined in the following statement by A. E. Wishon, vice-president and general manager of both companies: "The San Joaquin Light & Power Corporation is well equipped to take care of all power demands of its system, even in the face of the threatened water shortage. Little hydro power has been available for several months, but this has made no difference, because our two big steam plants, at Buttonwillow

and at Bakersfield, have taken care of the demand. We are connected by the biggest tie line in California with the Great Western Power Company, so that we may draw upon that company's generating resources. The Great Western Power Company has substantial storage in Lake Almanor, and its three huge hydro plants on the Feather River can run without interruption. In addition, a large new steam plant in San Francisco went in operation on Dec. 5."

The Southern California Edison Company reports that prevailing drought conditions will in no way curtail its power supply. By taking advantage of abundant and low-priced natural gas for fuel in its steam plants, the company has conserved water in its storage reservoirs, according to R. H. Ballard, president. Huntington Lake is 65 per cent full, and 14,500 acre-feet of water remain in Florence and Shaver Lakes.

A.I.E.E. Nominations Announced

Nominations for officers to be elected in the spring of 1930 have just been announced by the American Institute of Electric Engineers. They are as follows: For president—William S. Lee, vice-president and chief engineer of the Duke Power Company, Charlotte, N. C. For vice-presidents—I. E. Moultrop, chief engineer, Edison Electric Illuminating Company of Boston; H. P. Charlesworth, vice-president, Bell Telephone Laboratories, New York City; T. N. Lacy, chief engineer, Michigan Bell Telephone Company, Detroit; George C. Shaad, dean of the School of Engineering and Architecture, University of Kansas; H. V. Carpenter, dean of Mechanics, Arts and Engineering and director of Engineering Experiment Station, State College of Washington. For directors—A. B. Cooper, general manager, Ferranti Electric, Ltd., Toronto, Ont.; A. E. Knowlton, associate professor of electrical engineering, Yale University, New Haven, Conn.; R. H. Tapscott, electrical engineer, New York Edison Company.

Controversy Still Waging Over Flathead Project

A brief petitioning the Federal Power Commission to deny the application of the Rocky Mountain Power Company for a preliminary permit to develop power on Flathead Lake and Flathead River, Mont., and issue a permit to Walter H. Wheeler for the same purpose was filed Dec. 5, it was announced at the commission.

Mr. Wheeler agrees to pay the Flathead Indians $1.12½ per horsepower year for the average amount of power used, compared with $1 offered by the Rocky Mountain Company, according to the brief. The Rocky Mountain Company, he states, proposes to develop 68,000 hp. from site No. 1, while Mr. Wheeler proposes to develop 105,000 hp. Mr. Wheeler further contends that it is doubtful if the Rocky Mountain Company will develop the four other power sites on the project, whereas he proposes to push development of all five sites to early completion through a program of selling electric power for less than anywhere else in the United States.

The commission has the choice between two plans to develop the Flathead project, the brief points out. One of these plans, Mr. Wheeler declares, is of importance to the agricultural and chemical industries, and the other of concern only to the power monopoly of Montana, which would control the state with the addition of Flathead to its present holdings.

Business Forecast

THE *Business Week* will print the following outlook for business in its issue of Dec. 25:

"The business weather signs for the week show conditions about what might be expected for the season and in view of events during the past two months. Industrial activity and general trade are running below last year, but the contraction in industrial activity seems so far to have been more marked than that in retail trade. The last two weeks of the year are usually a very slack period in most basic industries, because of year-end shutdowns for inventory purposes. Holiday trade is reported generally to be about on a level with last year in volume, but with considerable shift in character of purchases.

"Slowing up is most evident among wholesalers and jobbers who are hesitant about placing orders because of uncertainty regarding the prospects of retail trade in the next few months."

El Paso Power Plant Unit Placed in Operation

The Engineers Public Service Company, New York, has announced that the first unit of 25,000-kw. capacity in the new Rio Grande station of its subsidiary, the El Paso Electric Company, El Paso, Texas, was put into service a few days ago.

The new plant burns natural gas piped from southwestern New Mexico fields and obtains its supply of condensing water from the Rio Grande irrigation system. Construction was started early this year and was rushed to completion to take care of the increasing demand for power in El Paso, notably by the new electrolytic copper refinery of the Nichols Copper Company now nearing completion.

News of Canada

Large Developments in Prairie Provinces — New Contract for Beauharnois—Victoria Plant to Be Enlarged—Ontario Plans—Nova Scotia Projects

NEVER before in the history of the Canadian Prairie Provinces has there been as much activity in hydro-electric development as at present. Four large undertakings are under construction, which will ultimately provide 445,000 hp. in Manitoba, Saskatchewan and Alberta. Two of the undertakings, Seven Sisters Falls and Slave Falls, are situated on the Winnipeg River in Manitoba, and have ultimate designed capacities totaling 325,000 hp.; another at Island Falls, on the Churchill River in Saskatchewan, will generate 84,000 hp.; and the fourth, on the Bow River in Alberta, will develop 36,000 horsepower.

New Beauharnois Contract

The Beauharnois Power Corporation, whose contract to sell 250,000 hp. of energy from its coming hydro plant on the St. Lawrence River to the Ontario Hydro-Electric Power Commission was noted last week (page 988), has announced that it has also made a contract by which the Montreal Light, Heat & Power Consolidated will take 150,000 hp. of the 500,000 hp. to be developed. It is expected that before the completion of the plant the corporation will have disposed of the remaining 100,000 horsepower.

To Enlarge Victoria Plant

Preparations for enlarging the principal hydro-electric station supplying Victoria, B. C., include the letting of a contract by the British Columbia Electric Railway Company, to the Vancouver Engineering Works, Ltd., for construction of a steel penstock nearly two miles in length at a cost of $387,000. This pipe will have a diameter of 5 ft. and will extend from the balancing reservoir to the Jordan River power house. It will have to withstand enormous pressure, as the Jordan River plant is one of Canada's high-head stations, utilizing a fall of water from a height of over 1,100 ft. Other contracts have been placed for a 14,000-kw. generator costing $90,000 and an 18,000-hp. waterwheel at a cost of $70,000. The new generator and turbine unit is to be installed next summer.

Ontario Plans

It is estimated that the new power undertakings by the Ontario Hydro-Electric Power Commission during the next few years will involve an expenditure of close to $40,000,000 and will release some 680,000 hp. of electrical energy. Among these developments is the Chats Falls undertaking, on the Ottawa River, where 200,000 hp. will be developed at a cost of nearly $17,000,000. The Alexandria Falls project, on the Nipissing River, consisting of 54,000

hp., will be completed about the end of 1930, at an expenditure of approximately $8,000,000. A duplication of the Gatineau power transmission line and transformers will entail an expenditure of nearly $4,000,000; and the rural lines throughout the province will be extended 1,200 miles, at an outlay of nearly $5,000,000. Good progress is being made on the tenth unit of the commission's Niagara development. It is expected that this will be completed early in 1930.

NOVA SCOTIA PROJECTS

At a capital outlay of approximately $4,000,000 the Nova Scotia Power Commission has practically completed work upon three new power developments on the Mersey River, which are to supply electrical energy for the new mill of the Mersey Paper Company at Brooklyn, near Liverpool, N. S. Three sites have been harnessed together for the development of an aggregate of 31,000 hp. The power houses are at Upper Lake Falls, Lower Lake Falls and Big Ear Falls.

U. S. to Take Lead in Export of Power Equipment

Indications are that the end of 1929 will see the United States in the position of world supremacy in the export of power plant equipment, a place heretofore occupied by Germany. The total German exports in this line amounted to the equivalent of $128,000,000 in 1928 and is not expected to exceed this figure by any great extent this year. The government's figures show, on the other hand, that at the present rate, the American exports will pass the $150,000,000 mark for 1929.

Domestic manufacturers have always controlled the world markets in lesser electrical appliances. But in the matter of large generators, transformers, switchboards, and other equipment that goes into power stations, they have been somewhat at a disadvantage, because material of this type cannot be produced on a large scale.

In government circles the expected accendancy of American manufacturers into first place in the export of heavy electrical goods is regarded as particularly significant. It means, according to foreign trade experts, that American capital has gone before and initiated power development. Where American capital has gone, American equipment will follow, it is pointed out, not only because of the contacts between those interested in the developments and the manufacturers, but also because of frequent financial connections.

As far as any great need of foreign markets is concerned, the electrical manufacturing industry has less reason to worry than most other lines of trade, it is felt in official quarters. It is nevertheless believed that it will be beneficial to the industry in years to come to continue the present rate of American development in the world power field.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

OBITUARY

FRED D. HOLDSWORTH, engineer in charge of air-compressor design for the Sullivan Machinery Company at its Claremont, N. H. plant from 1900 to 1928, died Nov. 20. Mr. Holdsworth was born in Wales, Mass., Oct. 23, 1867. He was graduated from Worcester Polytechnic Institute in 1888, and after experience as mechanical engineer with the Rhode Island Locomotive Works and with the G. F. Blake Company, afterwards Blake & Knowles, he joined the Sullivan staff in 1900, remaining at Claremont as mechanical engineer in charge of air-compressor design until his retirement, about a year ago. During this time, he was awarded nearly 50 patents connected with the development of various Sullivan machines. Mr. Holdsworth was a member of the American Society of Mechanical Engineers.

JOHN C. VAN VLEET, safety engineer of the Buffalo General Electric Company, Buffalo, N. Y., died suddenly at his home in that city recently. Mr. Van Vleet was originally purchasing agent for the New York State Steel Company, now known as the Donner Steel Company. When ground was broken for the Charles R. Huntley station he was employed by the Stone & Webster Construction Company, which built the original plant for the Buffalo General Electric. It was through his efforts in safety work that the Buffalo utility won the trophy for the best no-accident record in a contest in 1928.

MAURICE A. OUDIN, 63, vice-president of the International General Electric Company, died at his home in Schenectady on Dec 4, following an illness with pneumonia. In 1891 Mr. Oudin joined the Thomson-Houston Electric Company, of Lynn, Mass., and continued in various capacities with its successor, the General Electric Company, at Schenectady. He was active in the power and mining interests, and served for a time as acting district manager of the Denver territory. On his return to Schenectady he was chosen to consolidate and extend the engineering work of what was then the foreign department. In 1919, the International General Electric Company was formed to take over all the activities of the parent company with relation to foreign business, and Mr. Oudin was appointed its first vice-president.

PERSONALS

W. R. WOOD, formerly senior vice-president of the International Combustion Engineering Corporation, was elected president at a recent directors' meeting to succeed George E. Learned, resigned. George L. Bourne was elected chairman of the executive committee.

HERMAN RUSSELL has been made president of the Rochester Gas & Electric Corporation to succeed the late Robert M. Searle. Mr. Russell has been with the company since 1904, rising to the position of vice-president in 1922.

L. M. GROW, of Toledo, has been appointed engineer for the Wooster Electric Company, Wooster, Ohio, to succeed F. H. Bussler, who recently resigned.

THORN DICKINSON, since 1925 with Ulen & Company on foreign construction work in Greece and Poland, has joined the Stone & Webster Engineering Corporation as engineer in the structural division. Previous to his foreign service, Mr. Dickinson worked on the design and construction of waterworks and power plants in this country.

E. B. NICHOLS has been appointed chief engineer of the Brown Instrument Company, of Philadelphia. Mr. Nichols has had a wide engineering

experience. A graduate in mechanical engineering of the North Carolina State College, he was at one time chief engineer of the Pfaudler Company, subsequently holding the same position with the Victor Talking Machine Company. Later he became associated with the Bell Telephone Laboratories, which connection he severed to join the Brown Instrument organization.

WILLIAM W. MILLER, manager of the industrial department of the General Electric Company, was formerly assistant manager of the department and not business manager, as reported last week in *Power*.

CLAUDE C. SMITH, pioneer central station operator and managing director for the past twenty years of the Bradford & Gettysburg Electric Light & Power Company, is now assistant to Robert S. Ashe, president of the Liberty Light & Power Company.

D. S. BROWN, who has been connected with public utilities in Cincinnati since 1913, has been appointed manager of the production department in charge of power plants of the Union Gas & Electric Company.

BUSINESS NOTES

UNIVERSAL BEARING METALS CORPORATION, Rochester, N. Y., has purchased the assets, processes and patents of Bearium Bearings, Inc., and will continue to supply Bearium bronze and alloys as heretofore, through the same sales organization. Officers of the Universal company are E. P. Langworthy, president and treasurer, and H. M. Rees, vice-president and secretary.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the appointment of R. B. Tuhey as district representative at Indianapolis, Ind., with offices at 517 Peoples Bank Bldg. S. H. Taylor has been made district representative at Los Angeles, Calif., with headquarters at 812 Mateo Street.

KING REFRACTORIES COMPANY, Buffalo, N. Y., announces the appointment of Garrett Burgess, Inc., 5050 Joy Road, Detroit, Mich., as its district sales agent in the State of Michigan.

SIMPLEX VALVE & METER COMPANY, Philadelphia, Pa., announces the appointment of Neville & Cleary, Inc., Candler Bldg., Atlanta, Ga., as its sales representatives in the Southeastern States. A. C. Hays has been placed in charge of the company's branch office at New Orleans, La.

WICKES BOILER COMPANY, Saginaw, Mich., announces the removal of its Detroit office to 2357 Union Trust Building.

TRADE CATALOGS

CONDENSERS — "Cleaning Condenser Tubes With Carboloy Tipped Reamers" is the title of an informative article published in the November number of *Carboloy* issued by the Carboloy Company, 350 Madison Ave., New York City.

COAL HANDLING—Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill., has issued a new booklet, No. 104, describing a rotary railroad car dumper, which has found wide use in the handling of coal at power plants.

FEEDWATER TREATMENT—The Korite system of feedwater treatments for high pressure boilers and refrigerating plants, and other industrial chemical treatments are extensively described in the 66-page illustrated bulletin recently issued by Korite, Inc., 89-97 Bickford St., Boston, Mass.

VALVES—A complete line of valves, fittings and supplies for all uses and pressures is presented in a new 625-page cloth-bound catalog, No. 4, just issued by the Pittsburgh Valve, Foundry & Construction Company, 26th St. and Allegheny Railroad, Pittsburgh, Pa. The first half of this book is devoted to price lists and descriptions of the various materials, grouped in order of pressures, from lowest to highest. The second half pertains to engineering data, giving dimensions of all valves and fittings. It is well illustrated and should prove valuable in piping layout work.

DEAËRATORS — A combined deaërator and hot-water generator for supplying hot, deaërated water to heating and hot-water systems is described in Bulletin 686, distributed by the Cochrane Corporation, 17th St. Bel. Allegheny Ave., Philadelphia, Pa. Another publication of the company, Bulletin 685, is devoted to the selection of traps, drainers and dischargers to suit operating conditions.

WELDING.—Specification sheets covering a 300-amp. welder have been issued recently by the Lincoln Electric Company, P. O. Box 683, Cleveland, Ohio. The arc welding of pipe lines is described in another new bulletin of the company, which illustrates some of the actual uses the welder has been put to in field work.

HEATING—"The Most Efficient Central-Heating System in the World" is the title of a 30-page, illustrated booklet recently issued by the General Iron Works Company, Cincinnati, Ohio, which describes the "Hot-Kold" system of industrial and residential heating.

CONDUITS — A new non-corrosive raceway for under-floor wiring in concrete floors, known as "G-E Fiberduct," is described in an 8-page illustrated booklet recently issued by the General Electric Company, Merchandise Department, Bridgeport, Conn. The feature of this system of wiring is that neat-appearing outlets may be installed safely and economically at any point and at any time during the life of the building.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25 @$2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.20
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.40@ 1.50

FUEL OIL

New York—Dec. 19, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Dec. 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.695 per bbl., or 42 gal.; 26@28 deg., $1.745 per bbl.; 28@30 deg., $1.795 per bbl.; 30@32 deg., $1.845 per bbl.; 32@36 deg., gas oil, 4.526c. per gal.; 37@40 deg., distillate, 5.73c. per gal.

Pittsburgh—Dec. 11, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia—Dec. 13, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Dec. 10, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Dec. 11, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.22½ per bbl.

Boston—Dec. 16, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.4c. per gal.

Dallas—Dec. 14, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Chualar—Pacific Gas & Electric Co., 445 Sutter St., San Francisco, is having plans prepared for the construction of a substation here. Estimated cost $55,000. Private plans.

Calif., Lodi—City, J. D. Blakely, Clk., is having surveys made for the construction of a dam on Mokelumne River, also power generating plant with power line tieing in with distribution system on Cherokee Lane. Estimated cost $455,000. L. F. Barzelotti is city engineer.

Colo., Boone—S. A. Gerrard Co., 240 West 6th St., Cincinnati, O., or c/o R. A. Rollander, Colorado Bldg., Pueblo, plans the installation of seven electric cenrtifugal pumping plants at Boone 20 miles east of Pueblo in connection with irrigation development. Estimated cost $25,000.

Colo., Pueblo—Southern Colorado Power Co., c/o W. N. Clark, Gen. Mgr., Colorado Bldg., appropriated $150,000 for extensions and improvements to power plants at Pueblo, Canon City and Cripple Creek.

Colo., Pueblo — State Board of Corrections, c/o F. S. Hoag, Grand and Union Aves., will soon receive bids for extensions and improvements to state asylum to include laundry, boiler and heating plant improvements etc. $45,000.

Conn., Bridgeport—Bridgeport Gas Light Co., 815 Main St., awarded contract for a 1 and 2 story addition to gas generator plant on Howard Ave., to T. J. Pardy Construction Co., 1481 Seaview Ave. Estimated cost $25,000.

Ia., Audubon—Iowa Public Service Co., awarded contract for the construction of an electric plant on Market St. to Zitterall-Mills Construction Co., Webster City. Estimated cost $40,000.

Md., Baltimore—Mayor and City Council, City Hall, awarded contract for the construction of a 35 x 65 ft. waterworks pumping station to North-Eastern Construction Co., 6 West Madison St. Estimated cost $88,650.

Mass., East Braintree (mail Braintree)—Old Colony Gas Co., Quincy Ave., awarded contract for the construction of an engine room to T. Mulcare Co. Inc., 66 Western Ave., Brighton. Estimated cost $40,000.

Mass., Fall River—National Service Co., 150 Congress St., Boston, plans the construction of an artificial ice plant here. Estimated cost $40,000. R. B. Engineering Co., 11 West 42nd St., New York, N. Y., is engineer.

Mass., New Bedford—New Bedford Gas & Edison Light Co., Purchaser St., plans addition to power plant on Water St. Stone & Webster, Inc., 49 Federal St., Boston, are consulting engineers.

Mass., South Hadley Falls—Carew Mfg. Co., Canal St., awarded contract for addition and alterations to boiler house on Canal St. to Adams & Ruxton Construction Co., 1387 Main St., Springfield. Estimated cost $40,000.

Mass., Springfield—United Electric Light Co., 73 State St., Boston, is having plans prepared for the construction of a power sub-station at Forest Park District, Converse St. Estimated cost $40,000. McClintock & Craig, 458 Bridge St., are associates architects.

Mich., Dearborn — Hospital Commission, is having plans prepared for the construction of a group of hospital buildings including power house, laundry, etc. on Maple Ave. Estimated cost $1,000,000. Smith Hinchman & Grylls, 800 Marquette Bldg., Detroit, are architects.

Mich., Detroit—Detroit Edison Co., 2000 Second Blvd., will build a 3 story, 100 x 150 ft. sub-station on Howard St. Estimated cost $375,000. Private plans. Work will be done by separate contracts.

Mich., St. Clair Shores—City plans the construction of a pumping station in connection with sewage system at Eleven Mile Rd. Estimated cost $700,000. Hubbell, Hartering & Roth, 2600 Buhl Bldg., Detroit, are engineers.

Mo., Kansas City—United States Cold Storage Co., 500 East 3rd St., plans a 5 story addition to cold storage plant. Private plans.

Neb., Lincoln—Nebraska University, awarded contracts for motors to Westinghouse Electric & Mfg. Co., Electric Bldg., Omaha; piping to B. Grunwald, 1110 Farnum St., Omaha, $88,700, crane to Armington Engine So., Euclid O. in connection with power plant.

N. Y., Manlius—St. Johns Military Academy, raising funds for the construction of a school building and power unit. Maturity late in 1930.

N. Y., New York—Bd. of Transportation, J. H. Delaney, Chn., will receive bids until Jan. 7 for the construction of substations 5 and 6 for Rapid Transit railroad.

N. Y., New York—Four Hundred Fifty 7th Ave. Corp., J. Nelson, Pres., 247 West 38th St., will receive bids about Jan. 15 for the construction of a stores and office building at 446-7 7th Ave. Estimated cost to exceed $2,000,000. H. C. Severance, 36 West 44th St., is architect.

N. C., Kinston—City plans extensions and improvements to electric light plant including generator. Estimated cost $125,000. W. C. Olsen, 5 Exchange Pl., Raleigh, is engineer.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., Insurance Bldg., awarded contract for the construction of an electric power plant to Byllesby Engineering Co., 208 South Clark St., 208 South Clark St., Chicago, Ill. Estimated cost $1,000,000.

Okla., Tulsa—Grand Hydro Co., W. E. Hudson, Pres., Ritz Bldg., has been granted permit to construct a hydro-electric development, including power plant and dams on the Grand River. Estimated cost approximately $26,000,000. Engineer not selected.

Pa., Pittsburgh—U. S. Engineers Office, will receive bids until Jan. 13 for a hydro-electric plant for Lock No. 7 on Allegheny River.

Pa., Polk—Polk State School, awarded contract for new engine generator units and appurtances to Elliott Co., Morris Bldg., Philadelphia, $41,352.

Tex., Big Springs—Texas & Pacific Ry. Co., Dallas, will soon award contract for the construction of a roundhouse, machine shop, power house, etc., here. Estimated cost $175,000. E. F. Mitchell, is chief engineer.

Tex., Fort Worth—Victory College, is having plans prepared for the construction of a group of college buildings, including administration building, power plant, laundry, etc., at Shaw and Hemphill Sts. W. C. Hedrick, First National Bank Bldg., is architect.

Tex., Harlingen—Central Power & Light Co., Frost Bldg., San Antonio, will receive bids until Dec. 23 for the construction of a cold storage plant here. Estimated cost $75,000. J. Marriott, Frost Bldg., is architect.

Tex., Marble Falls — Syndicate Power Co., Marble Falls, transferred permit to Emery, Peck & Rockwood Co., Seguin, for constructing power dam one mile below Marble Falls on the Colorado River to develop power for commercial uses and also as a water supply to other towns. Estimated cost $2,500,000. Private plans.

Tex., San Antonio — Scobey Fireproof Storage Co., c/o F. E. Scobey, Pres., 315 North Medina St., will receive bids after Jan. 1 for the construction of a 4 story, 100 x 166 ft. cold storage warehouse. Estimated cost $200,000. Engineering Service Corp., Post Dispatch Bldg., Houston, is architect and engineer.

Wis., Eau Claire—Northern States Power Co., R. F. Prack, V.-Pres., 231 South La Salle St., Chicago, Ill., acquired plant of Dells Paper & Pulp Co., here, and plans to expend $600,000 in additions and improvements. Byllesby Engineering & Management Corp., 231 South La Salle St., Chicago, Ill., is engineer.

Ont., Chatham—Public Utilities Commission, W. Reynolds, Mgr., plans extending power lines, and installing additional equipment, transformers, etc. Estimated cost $20,000.

Equipment Wanted

Alternator—New York, N. Y.—Dept. of Hospitals, E. F. Cadley, Acting Comr., Municipal Bldg., will receive bids until Dec. 27 for a 2,300 v. 300 kw. 3 ph. alternator to supply additional current for light, heat and power for Sea View Hospital and New York City Farm Colony at Castleton Corners, Staten Island.

Generators—Charleston, S. C.—Supt. of Lighthouses, will receive bids until Dec. 30 for two, four or six units of 4 kw. Diesel engine operated generators.

Pump—San Francisco, Calif.—City plans the installation of a motor driven centrifugal pump with auxiliary engine at Mills municipal airport.

Pump, Etc.—Chatham, Ont.—City Council, pump, etc. for proposed sewage system. Estimated cost $110,000.

Pumping Equipment—San Antonio, Tex.—G. & C. Hagelstein, 310 North St. Marys St., pumping equipment, etc. for proposed waterworks. Estimated cost $35,000.

Pumps, Etc., Fort Monroe, Va.—Contracting Officer, will receive bids until Jan. 2 for two horizontal duplex pumps motor driven or gear connected, two horizontal centrifugal pumps, motor driven, driect connected, one dry feed line machine motor driven gravity solution feed, and two vertical pressure filters.

Water Heater, Fans, Boiler Feed Heater, etc.—Jersey City, N. J.—P. Simeone & Co., Inc., 22 Journal Sq., Archts., taking bids on elevators, rotary automobile lift, 80,000 gal. water tank, sprinkler system, water heater, fans, boiler feed heater and accumulating tank in connection with power plant for Brunswick Laundry Co., Inc. Estimated cost $160,000.

Industrial Projects

Calif., Oakland—H. B. Body Co., 19th and Livingston Sts., will build a cannery and boiler house on West 66th Ave. Estimated cost $100,000.

Conn., Middletown—Wilcox, Crittenden & Co. Inc., 3 South Main St., awarded contract for the construction of a 2 story, 100 x 185 ft. factory and 50 x 55 ft. boiler house at High St. and Pameacha Ave. to T. H. Sellew, Cromwell. Estimated cost $40,000.

Ill., Springfield—Allis Chalmers Mfg. Co., O. Falk, Pres., 62nd and Greenfield Sts., West Allis, Wis., is having preliminary plans prepared for the construction of a 1 story factory for the manufacture of motors, generators, transformers and other electrical machinery here. Estimated cost $150,000. Klugg & Smith, 69 East Wisconsin Ave., Milwaukee, Wis., are engineers.

Mass., Springfield—Springfield Bronze & Aluminum Co., Page Blvd., awarded contract for the construction of a 1 story, 85 x 145 ft. factory on Page Blvd. to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $45,000.

Mich., Detroit — Kelsey Wheel Co., 3600 Military Ave., is having plans prepared for the construction of a 1 and 2 story, 300 x 800 ft. factory for the manufacture of metal rims for automobile wheels on Livernois Ave. Estimated cost $700,000. A. Kahn, 1000 Marquette Bldg., is architect. Electric motors will be required.

Mich., Detroit—Michigan Tank & Galvanizing Co., 14101 Prairie Ave., is having plans prepared for the construction of a 1 story, 150 x 400 ft. tank factory on Tireman Ave. Estimated cost $180,000. Private plans.

Mich., Detroit — Timken Detroit Axle Co., West Fort and Clark Sts., is having plans prepared for a 2 story, 100 x 100 ft. factory for the manufacture of automobile axles on West Fort St. Estimated cost $60,000. Private plans. Machinery and equipment for finishing axles and parts will be required.

Miss., Vicksburg—National Portland Cement Co., Santa Fe Bldg., Dallas, Tex., acquired 46 acres of land on Mississippi River at Fort Hill here, and plans the construction of a cement plant, 3,500 bbl. daily capacity. Estimated cost $1,000,000.

Mo., St. Louis—Johnston Tin Foil & Metal Co., 6106 South Broadway, is having preliminary plans prepared for a 2 story, 100 x 104 ft. addition to factory at 6130 South Broadway. C. H. Deiterling, 1320 Central National Bldg., is architect.

N. H., Walpole—American Mineral Products Co. Inc., W. B. Ewing, Hartford, awarded contract for a 1 story, 40 x 200 ft. feldspar plant here. Estimated cost $40,000. W. Furey, 983 Main St., Hartford, is architect.

N. J., Newark—R. B. Flatt, 600 Bloomfield Ave., Bloomfield, Archt., is receiving bids for a 2 story addition to factory at Miller St. and Ave. A here for Positive Lock Washer Co., Ave. A, Newark. Estimated cost $40,000.

N. J., Perth Amboy—American Smelting & Refining Co., Maurer St., will build a 1 story, 70 x 140 ft. addition to plant on State St. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

N. Y., New York—R. Hoe & Co., 138th St. and East River, plans the construction of a 3 story press manufacturing plant at Walnut and 137th Sts. Estimated cost $125,000. F. S. Parker, 119 West 57th St., is architect.

O., Cleveland—Accural Metal Products Co., c/o J. C. Chandler, Terminal Tower, had plans prepared for a 1 story, 90 x 200 ft. factory on Chardon Rd. Estimated cost $60,000. E. McGeorge, 3030 Euclid Ave., is architect.

O., Warren—Youngstown Pressed Steel Co., W. W. Galbreath, Pres., awarded contract for a 1 story, 60 x 382 ft. enameling plant to The Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $50,000.

Pa., Ambridge—National Electric Products Co., N. C. Lamont, Gen. Mgr., 14th St., plans a 1 story, 125 x 180 ft. plant at 14th and Duss Sts. Estimated cost $50,000. S. F. Mali, 14th St., is engineer. Work will be done by separate contracts.

Pa., Etna—Spang Chalfant & Co., 2317 Clark Bldg., Pittsburgh, plans alterations to pipe mill, including complete change in power system, moving galvanizing plant, new motor for 60 cycle power and new pine handling machinery. Estimated cost $500,000. Private plans.

Pa., McKeesport—Columbia Radiator Co., F. C. Painter, Secy. and Treas., 3200 Walnut St., awarded contract for the construction of a 1 story, 100 x 450 ft. foundry, machine shop and warehouse to The Austin Co., Union Trust Bldg., Pittsburgh. Estimated cost $250,000.